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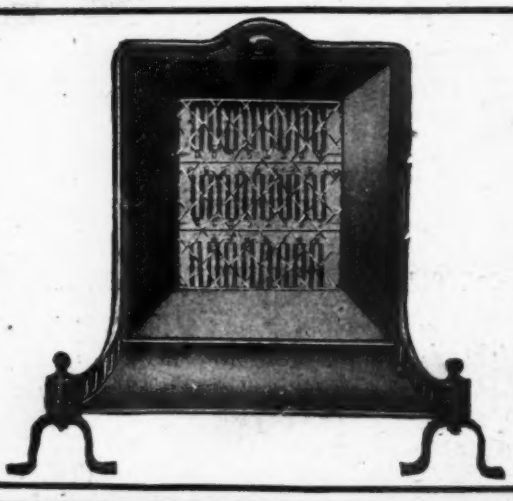

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ELECTRICAL REVIEW.

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THE TRAINING OF ENGINEER OFFICERS.

THE *Génie Civil* quotes from a speech delivered by Dr. von Rieppel, President of the Verein deutscher Ingenieure, a criticism of the training of German officers which, in view of certain facts which have come to our knowledge, is not without interest to our own authorities. The speaker said that Germany did not foresee that the war would become an economic and technical war; the military schools were designed solely to produce men fitted to command, and familiar with the art of war, and economic and technical questions were practically ignored by them. He had been struck by the difference between their own ideas on this subject and those of the French when he visited the Universal Exposition of 1900; as a member of the jury on civil engineering works, he had several times had to judge splendid buildings of which the architect was a French officer, and he was surprised to learn that a large number of French officers received a very comprehensive training, and at the end of their studies had to pass examinations in engineering. These young officers often acted as engineers, especially in the colonies, where they were able to make use of their general knowledge and render valuable service in connection with economic and technical matters. There was nothing of this kind in Germany, and this deficiency had led to serious results. During recent years the technology of the arms of war had made unprecedented progress; industry had provided the officer with greatly improved, but complicated, weapons, the mechanism of which he did not clearly understand. The German officer was accustomed to receive with material instructions for its use, and did not seek to become better acquainted with it, looking upon industrial technology as a thing apart, with which he need not trouble himself, and this false idea led him to under-estimate the value of industry with regard to the art of war. Modern weapons had to be served by specialists who must possess not only the usual qualities of the soldier, but, above all, technical experience and professional skill; the German officers were not fitted to control such men, for in their case the purely military point of view was a secondary consideration. In future the training of their officers must be regarded from a totally different aspect.

Now, we give place to none in our heartfelt admiration of the professional skill and indomitable courage of our Royal Engineers, who in their own sphere are unexcelled; but, through no fault of their own, if our information is correct, they suffer from precisely those deficiencies of training to which Dr. von Rieppel draws attention in the case of the Germans. We refer particularly to those branches of engineering which fall outside the military operations, such as the use of electric light and power, water supply, the industrial development of large areas of country, &c. It is quite a common thing to find behind our lines several little petrol-electric sets at work within a few yards of each other, each supplying a different department, and all, of course, devouring petrol, as well as capital outlay, and working under uneconomical conditions of loading, where a single properly-planned installation would have served the lot at less than half the cost, and twice the efficiency. Even where a local supply of electric power has been available, independent sets

have been put down. Wholly unsuitable plant has been requisitioned from home owing to the lack of technical knowledge on the part of the local engineer officer in command. Petrol has been employed where coal would have been preferable, because the latter can be supplied by small vessels making short voyages, whereas petrol comes from far overseas in large and costly oil-ships, which are a special object of Hunnish hate, and can obviously only make one voyage for 10 by a collier. The cost of coal may be greater, though this is questionable—but here the importance of saving tonnage for food supply ought to be considered by *the engineer on the spot in France*. Again, in organising electric supply schemes regard should be had to the future, when peace returns; all such work should be carried out so as to be of permanent value to the French population, at their standard voltage and frequency, and on their recognised lines, so that the plant may be taken over by them on the most satisfactory terms—but is this done? We believe not, with the result that large sums are being expended with the smallest prospect of any ultimate return.

Such questions as these demand broad views and wide knowledge, which can only be gained in the school of experience. Their correct solution is of immense importance, not only to the efficient conduct of the war, but also to our finances and to the prosperity of the peoples concerned after the war. They may seem to be far-fetched; they are not. Narrow views on the scope of an engineer officer's duties and responsibilities are out of date, and must go. It may be thought that the problem can be solved by commissioning as officers men who in civil life are engaged in such work, and this is perfectly true, but only on one condition—that they are invested with full powers to carry out their plans without interference. This, we believe, has not been the case, and if such wide powers cannot be entrusted to engineer officers who are not professional soldiers, then the latter must be provided with such an adequate and catholic training in the sciences of engineering economics and industry as will enable them to carry out the work themselves.

Overwork and Under-Production.

It was perhaps somewhat unfortunate that the exigencies of the war situation necessitated at Eastertime the appeal issued by the Ministry of Munitions for suspension in munition establishments of the customary holidays. Subsequent letters to the Press, and complaints of overwork frequently heard in munition works, point to the fact that both employers and workmen are suffering from the effects of strain.

For the greater part of the war period the majority of munition workers have put in considerably more hours per week than during normal times, while working at greater pressure and under less favourable conditions. The fact that the returns of output have, for the most part, increased rather than decreased, is due as much to the magnificent organising abilities of the managers and foremen as to the patriotic efforts of the workers.

In spite, however, of vastly superior organisation and control, the tendency of late appears to be a marked decrease in the efficiency of the worker due to overwork and long hours. The position is further accentuated by the present substantial combout in munition works of men for the Forces. One of the inevitable results of this last move must be a further call upon the remaining workers to make good the loss in output. Are the workers, under these conditions, as capable as they will doubtless be willing to respond to the appeal?

In view of the fact that the cost of production in munition works is far in excess of what employers would sanction were the direction entirely under their own control, and not influenced by the Ministry, it is perhaps worth the consideration of those responsible that, however willing the workers may be to respond to urgent appeals, such appeals should be accompanied with an intelligent appreciation of the necessity for providing at the earliest opportunity the required rest and recreation.

The notice recently issued to munition works by the Ministry, notifying the workers that a record of bad timekeeping was about to be instituted, has a distinct bearing upon the foregoing remarks. The great proportion of time lost in munition works may be summarised under three distinct heads— Sickness, strain, and indifference. The difficulty which most managers are at present experiencing is to determine whether an absentee has been sick, as stated, or indifferent. The fact that there is so great an amount of both sickness and indifference is probably due to overwork.

So long as the workers feel that they have a just cause for grievance in this respect, all appeals or threats from the Ministry as regards bad timekeeping will probably fail to achieve the desired results.

Export Trade Combinations.

The new Act passed in the United States legalising the association of firms or corporations in the American export trade came into force on April 10th. It is entitled "An Act to promote Export Trade and for other purposes." We have referred to this matter editorially on several occasions. Some particulars of the measure will be found in the Board of Trade *Journal* for May 16th. Export associations will require to be registered, and they will not be permitted either in the United States or elsewhere to enter into any agreement, understanding, or conspiracy, or do any act which artificially or intentionally enhances or depresses prices within the United States of commodities of the class exported by such association, or which substantially lessens competition within the United States, or otherwise restrains trade therein. The "Webb" Bill, to which we drew attention in 1917, originated from a recommendation of the Federal Trade Commission, whose work we have also alluded to in these pages from time to time. It was clear from that Bill, as it is also from the Act now in force, that export trade combines are desired, and it is probable that a large number will be formed in the various trades of the States as a means for cultivating a greatly increased foreign trade, and meeting the efforts which Continental trusts may be expected to put forth. Our own Government Departments have been attacked by the merchants because they have advocated the same kind of effort on the part of British manufacturers. Such opposition, however, by the circumstances of the case, ought to be doomed to defeat. A policy of co-operation in export trade has been supported by us for many years past, and we regard it as inevitable, but if those who organise themselves into associations for carrying that policy into effect alienate the sympathies of those who have it in their power to help them they will be introducing instability at the foundations of the edifice they seek to build. The British technical and trade Press has done more than all the associations in existence in this industry to foster foreign trade and to keep connections alive during the period of the war. It has struggled with all sorts of adversity and difficulties, and has faced problems that neither secretaries nor publicity departments can have any knowledge of. Yet in spite of all those difficulties, circulars have reached our hands which contain an attack on the Press, accompanied by a series of half-truths and misrepresentations which are totally unworthy of any organisation possessed of the most ordinary feelings of common decency. We may have occasion to return to this matter.

LEEDS AUTOMATIC TELEPHONE EXCHANGE.

On Saturday last the new automatic exchange of the Post Office Telephone Department at Leeds was brought into operation. The exchange is of the full automatic Strowger type, for a five-figure system. Equipment is provided for 6,800 subscribers' lines, with an ultimate capacity for 15,000.

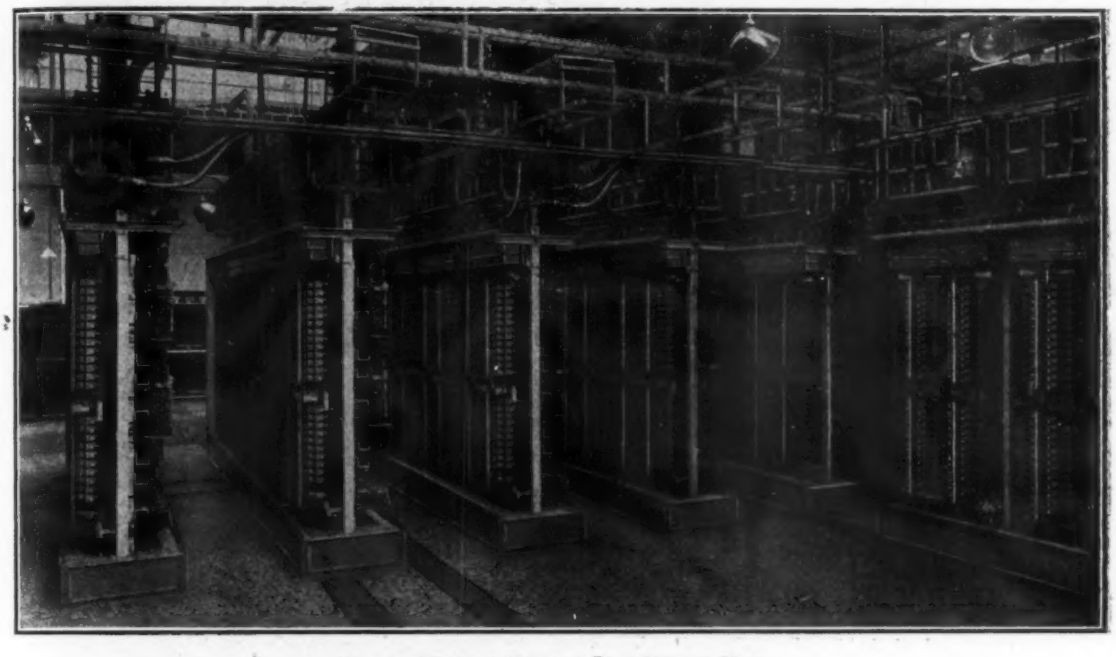

Fig. 1.—General View of Line Switch Units.

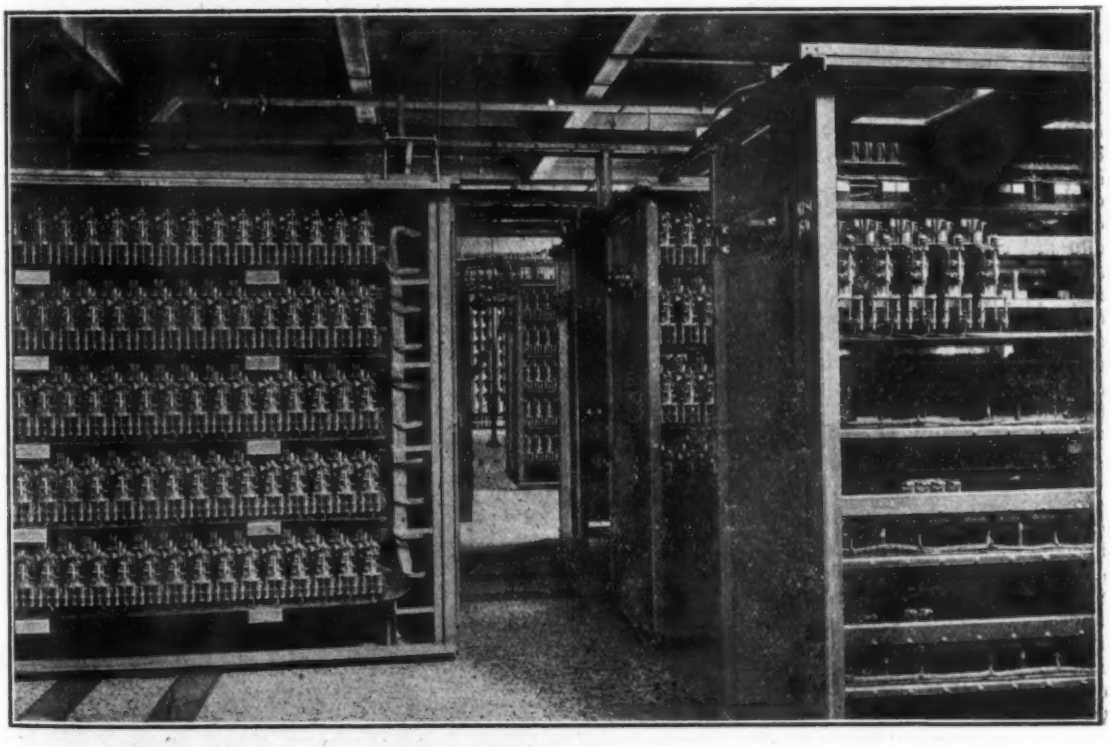

Fig. 2.—First Selector Boards.

Each subscriber's line terminates on a line switch circuit which, when energised by the removal of the receiver, extends the subscriber to one switch out of a group of first selectors. This apparatus receives the impulses from the subscriber's dial for the first digit, and extends the line to a second selector to accept the impulses for the second digit; similarly a third selector deals with the third digit, and finally a connector switch receives the tens and units digits, and connects the calling subscriber to the wanted line.

The plant provides for 68 units, each capable of accommodating 100 subscribers' lines; 46 of these units are designed each to carry a maximum of 10 *originated* calls simultaneously, with a capacity for 20 calls; the remaining

22 are each fitted for a maximum load of 20 originated calls simultaneously. For calls *incoming* to each unit, the design is as follows :—

4 units connector switch capacity for 19 calls ; switches fitted for 14 calls simultaneously.
6 units connector switch capacity for 19 calls ; switches fitted for 13 calls simultaneously.
2 units connector switch capacity for 16 calls ; switches fitted for 13 calls simultaneously.
10 units connector switch capacity for 16 calls ; switches fitted for 12 calls simultaneously.
46 units connector switch capacity for 16 calls ; switches fitted for 10 calls simultaneously.

Trunk and junction calls originated by subscribers are obtained by dialling " 0," and 200 outlets are available for this service. These lines terminate on manual positions in the Leeds Trunk Exchange fitted with a multiple of the junctions and short trunk circuits outgoing to other exchanges, so that, as far as possible, a " no-delay " service for such calls will be afforded. For long-distance calls, the calls are ticketed, and mature from a group of additional positions in the Leeds Trunk Exchange, each position being fitted with a group of junctions outgoing to the Automatic Exchange ; 226 junctions to the Automatic Exchange are available, each terminating on a 1st selector switch. Calls from distant sub-exchanges for Leeds subscribers are dialled direct by the sub-exchange operators. In this manner 144 circuits are operated, each circuit terminating on a 1st selector in the Automatic Exchange. To obtain trunk and junction calls over these circuits the sub-exchange operator dials " 0," and obtains the manual operator in the Leeds Trunk Exchange ; 40 circuits, separate from those used by subscribers, are provided for this purpose. This group of lines is marked to indicate to the Leeds operator that the call is from a sub-exchange, and will be controlled at that point.

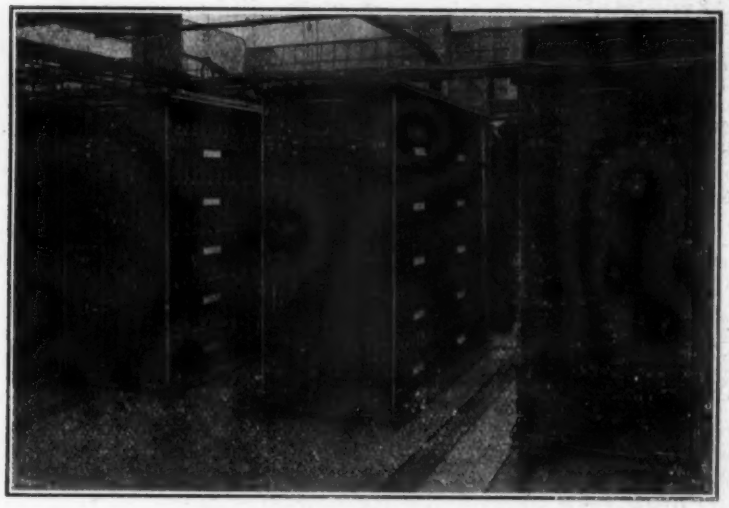

Fig. 3.—Second Selector Boards.

The manual board in the Trunk Exchange also deals with calls originated by call-office subscribers, so that the necessary fee can be collected. Two 100-line switch units are set apart for this service, the trunks outgoing from these units being wired so that immediately the receiver is taken off the hook the caller is connected to the manual position. The circuits are therefore dealt with precisely on manual lines for originating calls. Calls incoming to such numbers are, however, dealt with automatically, as in the case of an ordinary automatic subscriber. Coin-box and party-line subscribers are dealt with on a full automatic basis. The former have access to a separate group of " 0 " level circuits for trunk and junction calls, to indicate to the operator that the coins should be deposited before the connection is established. For calls to automatic subscribers, the apparatus at these subscribers' offices is designed to short-circuit the transmitter, when the called subscriber replies, until the penny is deposited. The party-line subscribers are arranged on a two-party-line basis, one subscriber " X " being rung on the " A " line, and the other " Y " on the " B " line ; each subscriber is allotted a separate number in a different hundred group, the connector switches of the " Y " group being arranged to ring on the " B " line, instead of on the " A " line, as for other switches.

Originating calls from party-line subscribers are dealt with on a line switch common to the two subscribers, and mature similarly to those of ordinary direct subscribers.

The necessary electrical energy for operating the Automatic Exchange switches, and providing the talking current for the subscribers' instruments, is derived from a 46-volt storage battery. This battery is in duplicate, so as to eliminate any risk of breakdown ; one battery is kept charged whilst the other is in service. The batteries are charged by a motor-generator set driven from the electric supply mains.

The Automatic Exchange equipment embodies the latest developments in automatic telephone exchange working :—

1. Facilities are available on primary line switch units for cross-connecting subscribers' lines to any line switch, thus affording means for distributing the originating traffic equally throughout the exchange.

2. Secondary line switches are fitted between the primary line switches and 1st selectors, to enable the originating traffic from each group of 100 subscribers to be spread over a larger group of selectors. Each of the trunks outgoing from the primary line switches is distributed among different groups of secondary line switches, each such group having access to 10 1st selectors. This scheme provides for the distribution of the traffic more uniformly over the entire exchange, and so affords better traffic conditions.

3. When the called subscriber is engaged, a " busy-back " tone is given to the originating subscriber ; if the engaged subscriber is called from the manual board, a " busy " flash signal is transmitted to the operator's cord circuit.

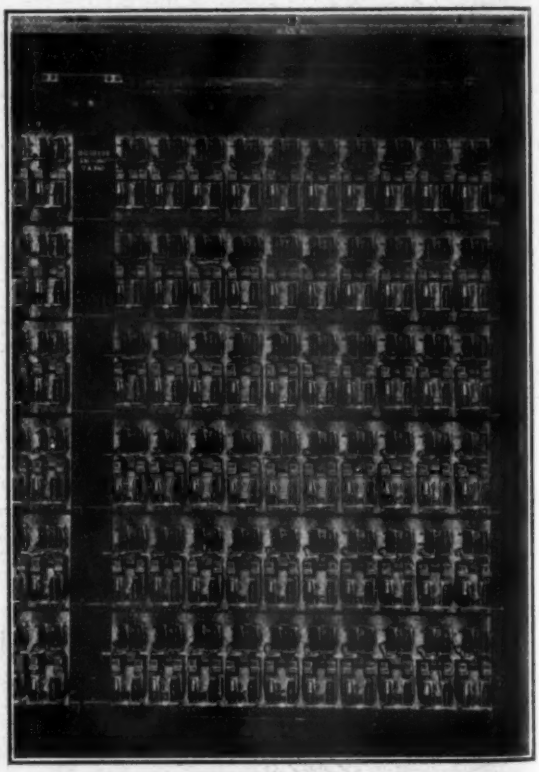

Fig. 4.—Repeater Rack.

4. When a called subscriber replies, the ringing current is tripped immediately.

5. The number of routes incoming to any unit can be varied without altering the permanent wiring. Increases in load incoming to any unit can thus be dealt with by merely inserting a connector switch on one of the spare multiple banks provided.

6. The meter of the originating subscriber is operated for completed calls between two automatic subscribers only.

7. Each switch, and the outgoing and incoming routes for each switch, are so designated as to enable calls to be traced backwards or forwards to the next switch without difficulty.

8. An alarm circuit is extended to the manual board during the night and on Sundays, when no engineering staff is on duty in the automatic exchange. The alarm is associated only with those circuits which actually affect the working of the Exchange—such as fuses blown and failure of ringing.

9. The master switch controlling the line switches associated with each primary and secondary line switch unit can be removed without displacing the line switches.

10. Standard positive supervision is afforded on the manual positions in the Leeds Trunk Exchange on all calls to and from automatic subscribers. Similar facilities are afforded to the sub-exchange operator dialling direct on the Automatic Exchange.

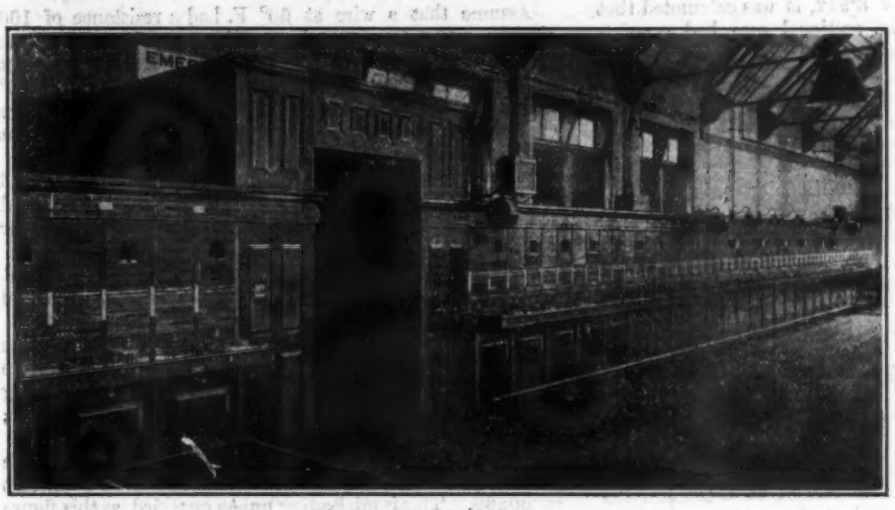

Fig. 5.—Toll Board.

The following is a complete list of the automatic installations which have been provided by the British Post Office :—

Exchange.	Type of equipment.	Date opened.	Extent of equipment. Present.	Ultimate.
Accrington ...	A	13/3/15	700 lines	1,500 lines
Blackburn ...	A	14/10/16	2,400 ,,	4,400 ,,
Chepstow ...	A	7/7/15	65 ,,	90 ,,
Dudley	W	9/9/16	500 ,,	1,600 ,,
Darlington ...	W	10/10/14	800 ,,	2,800 ,,
Epsom	A	18/5/12	500 ,,	1,500 ,,
Grimsby	S	Not yet opened	1,300 ,,	4,000 ,,
Hereford ...	L	1/8/14	500 ,,	900 ,,
Leeds	A	18/5/18	6,800 ,,	15,000 ,,
Newport (Mon).	A	14/8/15	1,800 ,,	3,500 ,,
Official	A	13/7/12	700 ,,	1,500 ,,
Paisley	A	15/7/16	1,100 ,,	2,150 ,,
Portsmouth ...	A	29/4/16	5,000 ,,	7,000 ,,
Stockport ...	S	Not yet opened	950 ,,	2,260 ,,

A denotes Automatic Telephone Manufacturing Co., Liverpool.
W ,, Western Electric Co., Woolwich.
S ,, Siemens Bros, Woolwich.
L ,, Lorimer System. Canadian Machine Telephone Co., Brantford, Canada.

The inauguration of the new exchange took place on Saturday last at 2 p.m., the change-over being started by the Right Hon. A. H. Illingworth, H.M. Postmaster-General; the actual transfer from the old to the new exchange occupied an astonishingly short time, being practically instantaneous. This exchange, which is the largest automatic exchange in Europe, has involved the laying of over 26,000 wires into the new building. For the past two or three years the Post Office engineering staff has been engaged on the complete rearrangement of the installations at the subscribers' offices, and, in addition, a large staff has been occupied in rearranging roof standards and overhead wires, generally replacing them to a large extent by underground cables. This work, together with the inspecting and testing-out of the Exchange installation, has been carried out by the local P.O. engineering staff, under the general direction of Mr. T. B. Johnson, superintending engineer of the North-Eastern District of England; Mr. E. H. Farrand has been responsible for the cabling and other line work, and Mr. E. S. Francis for the apparatus. Besides the Postmaster-General, others who were present at the opening ceremony included Sir Wm. Slingo, Engineer-in-Chief, G.P.O.; Mr. Dane Sinclair, Managing Director, Automatic Telephone Manufacturing Co., Ltd.; Mr. R. A. Dalzell, Chief Inspector of Telegraphs and Telephone Traffic, G.P.O., and many members of the Post Office commercial and engineering staffs. When the transfer was completed the Postmaster-General made the first "call," after which each subscriber's line was tested individually. In the course of a speech Mr. Illingworth said the new system was an illustration of the transference from absolute dependence upon the individual, to reliance upon the mechanical and automatic. He had been criticised for completing this installation in war-time, but he pointed out that the contracts had been placed so long ago as 1912, and actually the equipment was ready before the war broke out. When he inspected the unsatisfactory arrangements in the old manual exchange, he felt that such criticism was entirely out of place. He congratulated Mr. Johnson and the whole of the telephone staff upon the efficient manner in which the installation had been put into working order. Sir Wm. Slingo also spoke, and said it was one of the proudest moments of his life to see that exchange opened. For many years they had been struggling hard to get the automatic principle recognised. Automatic machinery must replace human effort in telephony, as in most other branches of industry; nothing could stop it, and the sooner the country developed this system thoroughly and comprehensively, the better it would be. The longer the development was delayed, the greater would be the amount of capital that would have to be sunk and ultimately scrapped in pursuing the manual system. The manual instruments displaced in Leeds were to be sent for war service at the Front. He now wanted to see Bradford linked up with the automatic service, so that Leeds and Bradford could work together.

In the evening a dinner was given at the Queen's Hotel by the directors of the Automatic Telephone Manufacturing Co., Ltd., to celebrate the occasion.

Electrotherapy.—The construction of a new electrotherapeutic and massage department has been completed at the Great Northern Central Hospital. It is estimated that 1,000 patients a year will attend.—*The Times.*

D

THE STANDARD RESISTANCE AND TEMPERATURE COEFFICIENT OF PURE ANNEALED COPPER.

By H. SAVAGE.

The average electrical engineer is often confused by the conflicting figures given by various authorities both for the standard resistance of copper and its temperature coefficient. The resistance is variously quoted for a certain section in square inches in lengths of 1,000 yards or one mile, or for the weight in pounds of such length, at various temperatures Fahrenheit, or in metric units and degrees of temperature Centigrade. The temperature coefficient is quoted per degree Fahrenheit or Centigrade, as the case may be, starting from various base temperatures as unity.

The standard resistance generally accepted for the past 18 years is that of the Committee on Copper Conductors, whose report was published in 1900 in the *Journal* of the I.E.E., Vol. XXIX, page 169, viz. :—

Resolved that Matthiessen's standard of ·150822 standard ohm resistance for a wire 1 metre long weighing 1 gramme at 60° F., be taken as the standard for annealed high-conductivity commercial copper.

From this, and the coefficient also adopted by them, and assuming a specific gravity of 8·912, it was calculated that one mile of copper of 1 sq. in. sectional area had a resistance of 0·042317 standard ohm at 60° F. The Committee also resolved :—

That Messrs. Clark, Forde & Taylor's temperature coefficient, as published in their pamphlet dated February 20th, 1899, be adopted, and that the average coefficient of 0·00238 per degree Fahrenheit be adopted for commercial purposes.

Although it can be shown that Matthiessen, in his work from 1858 to 1864, never set out to determine a standard for copper, yet the above resolutions were taken by common consent as a practical definition of what had come to be regarded as "Matthiessen's standard."

The Engineering Standards Committee, in 1904 (Interim Report, No. 7), accepted these resolutions in principle, but with slight variation in terms. They also took a specific gravity of 8·90, which gave a practical figure of 555 lb. per cb. ft. at 60° F. The Tables of Resistance of Copper Conductors issued by the E.S.C. were calculated on these standards.

In 1910 an investigation was made at Washington by the United States Bureau of Standards to determine the resistance and temperature coefficient of annealed commercial copper as produced under modern conditions by electrolytic methods. The results were published in the Official Bulletin of the Bureau, Vol. VII, No. 1. This gives the resistance as 0·153022 standard ohm for a wire 1 metre long weighing 1 gramme at a temperature of 20° C., a specific gravity of 8·89, and a linear temperature coefficient of 0·00394 per degree Centigrade. The Bureau proposed that these figures should be adopted as international standards.

It was shown that the temperature coefficient varied with the purity of the copper, but the figure given was for pure copper of the resistance quoted. It was also shown that the resistance varied by a definite amount per degree difference in temperature and not by a fixed percentage.

Researches had been made in other countries, and in 1913 the International Electrotechnical Commission adopted International Standards which approximate very closely to the American figures. The I.E.C. standards are :—

1. At a temperature of 20° C. the resistance of a wire of standard annealed copper 1 metre in length and of a uniform section of 1 sq. millimetre is 1/58 ohm = 0·017241 ohm.
2. At a temperature of 20° C. the density of standard annealed copper is 8·89 grammes per cb. centimetre.
3. At a temperature of 20° C. the "constant-mass" temperature coefficient of resistance of standard annealed copper, measured between two potential points rigidly fixed to the wire, is 0·00393 = 1/254·45 per degree C.

The resistance and density have been accepted by the Institution of Electrical Engineers, and issued in their Wiring Rules, 1916. These quote in a Table (page 30) the calculated resistance of electric conductors in standard ohms per thousand yards at 20° C., although the dielectric resistance in the corresponding column of the same table is in terms of megohms per mile at 60° F. How is the practical man to reconcile these figures, and what resistance shall he accept for every-day use? It is difficult to understand why, after a standard temperature of 60° F. has been sanctioned by long usage, he should be asked to express the conductor resistance of a cable at 20° C. and its dielectric resistance at 60° F.

Although it is highly desirable to adopt an international standard of resistance, it certainly should, in the writer's opinion, be expressed in the customary British units.

There is little difference in the actual resistance of annealed commercial copper as determined by various experimenters, but the practical man is quickly involved in difficulties when he attempts to bring the data to a common basis by means of the temperature coefficients quoted. It is necessary to get a clear idea of what this coefficient really is. The finding of the U.S. Bureau of Standards may be accepted, viz., that the resistance varies by a definite amount per degree. If this amount be calculated as a percentage, or a proportion of any resistance at a certain temperature, it gives a certain ratio, but if it be calculated on the resistance at a lower temperature, it will give a higher ratio, *i.e.*, the temperature coefficient will be higher when it is calculated from a lower temperature basis. An imaginary case will make this clear.

Assume that a wire at 60° F. had a resistance of 100 ohms, and that for every degree difference in temperature its resistance varied by 1 ohm, it would have a coefficient of 1 per cent., starting from 60°. The same wire at 40° would have a resistance of 80 ohms, but its temperature coefficient would be $\frac{1}{80} = 1{\cdot}25$ per cent. It is this point which is frequently overlooked.

A commercial analogy illustrates the point. A dividend of, say, 5 per cent. may be paid on stock of the nominal value of £100, but the percentage dividend to the investor depends upon the actual price paid for the stock.

Matthiessen's coefficient, determined in 1862, was not linear, *i.e.*, did not follow the straight-line law, but employed a formula involving two functions.

Messrs. Clark, Forde & Taylor, in 1899, found that the coefficient was practically linear, and they gave temperature coefficients per degree Fahrenheit as follows :—Starting from 32° F., it was ·00237 ; from 60° F., it was ·00224 ; and from 75° F., it was ·00217.

The Committee on Copper Conductors in 1900, and the E.S.C. in 1904, adopted the average temperature coefficient of ·00238. This is misleading unless qualified, as this figure is only correct when reducing to a standard temperature of 32° F., while in practice a standard of 60° F. was adopted and is implied by the other data in their report. It is evident that the proper coefficient should have been ·00224. The value of ·00238 frequently appears in Official Specifications as referring to 60° F.

The U.S. Bureau of Standards found the coefficient linear between 10 and 100° C. (50 and 212° F.), and nearly linear below 10° C. (150° F.).

The I.E.C. adopts a linear coefficient, but states that tests should be made between 10° and 30° C. (50—86° F.).

The following table is calculated to show the coefficients according to the various authorities, at certain temperatures in use :—

Deg. C.	Deg. F.	1.	2.	3.	4.	5.
0	32	·00215	·00237	Average,	·00238	·002370
15	59	·00212	·00224	·00238	·00223	·002227
15·5	60	·00212	·00224		·00223	·002222
20	68	·00211	·00220	Should be	·00219	·002183
23·9	75	·00209	·00217	·00224	·00215	·002150
25	77	·00208	·00216	at 60° F.	·00214	·002141

1 = Matthiessen, 1862.
2 = Clark, Forde & Taylor, 1899.
3 = Committee of Copper Conductors, 1900, and Engineering Standards Committee, 1904.
4 = United States Bureau of Standards, 1910.
5 = International Electrotechnical Commission, 1913.

It will be seen that the correct coefficient at 60° F. on the international basis is ·002222, and it will be sufficient

to take this figure for any temperature likely to be met with in practice.

The resistance of a conductor at a standard temperature being known, the resistance at any higher temperature can be obtained from the following formula :—

If R_s = Resistance at standard temperature.
R_x = " " the higher "
C = Coefficient per degree at standard temperature.
N = Number of degrees difference.
Then $R_x = R_s \times (1 + C N)$.

Most text-books refer only to the use of a coefficient in the above form—that is, on an ascending scale. When it is required to find the resistance at a *lower* temperature, the user not infrequently takes the factor $(1 + C N)$ and divides it into the resistance at standard temperature, thus—

$$\left(\frac{R_s}{1 + C N}\right)$$ which gives an incorrect result.

The proper formula is $R_x = R_s \times (1 - C N)$.

The best method to avoid errors of this kind is that adopted by Messrs. Clark, Forde & Taylor—viz., to use a series of *ratios* that the resistance at any temperature bears to the resistance at a standard temperature. The most practical plan is to use a table of ratios from 32° to 212° F. (0—100° C.) with 60° F. as unity.

The I.E.C. report only authorises the use of the coefficient between 10° and 30° C. (50° to 86° F.), but the United States Bureau of Standards has shown that the coefficient is linear up to 100° C., so that the table can safely be carried up to that temperature—viz., 212° F. The latter authority states that the coefficient is not quite linear below 10° C. (50° F.). The departure, however, is very small, and if the table is carried down to 32° F. on the same basis, the error will be negligible in practice.

The following table is based on the I.E.C. coefficient correct to 60° F., and subject to these assumptions :—

Ratios of Resistance of Pure Annealed Copper.

T° F.	Ratio.	T° F.	Ratio.	T° F.	Ratio.
212	1·3378	75	1·0333	52	0·9822
200	1·3311	74	1·0311	51	·9800
190	1·2889	73	1·0289	50	·9778
180	1·2666	72	1·0267	49	·9755
170	1·2443	71	1·0244	48	·9733
8160	1·2222	70	1·0222	47	·9711
1150	1·2000	69	1·0200	46	·9689
140	1·1778	68	1·0178	45	·9667
130	1·1555	67	1·0155	44	·9644
1120	1·1333	66	1·0133	43	·9622
110	1·1111	65	1·0111	42	·9600
100	1·0889	64	1·0089	41	·9578
90	1·0667	63	1·0067	40	·9555
85	1·0555	62	1·0044	39	·9533
84	1·0533	61	1·0022	38	·9511
83	1·0511	60	1·0000	37	·9489
82	1·0489	59	0·9978	36	·9467
81	1·0467	58	·9955	35	·9444
80	1·0444	57	·9933	34	·9422
79	1·0422	56	·9911	33	·9400
78	1·0400	55	·9889	32	·9378
77	1·0378	54	·9867		
76	1·0355	53	·9844		

Having determined the coefficient and the method of using it, a standard resistance can be easily calculated.

On the I.E.C. basis the resistance of an annealed copper conductor of a uniform section of 1 sq. in. at a temperature of 60° F., is 0·02401 ohm per 1,000 yards, or 0·042258 ohm per statute mile.

If tables for the resistance of electric conductors are calculated from the foregoing figures, the international standards will have been accepted, but in terms with which practice has made electrical engineers familiar.

Their adoption, therefore, would be distinctly advantageous until the general use of the metric system in this country renders them obsolete.

Zinc in Tasmania.—The Electrolytic Zinc Co., Risdon, Tas., has started up the first unit of its working plant. The estimated capacity is 10 tons daily, but it is anticipated that the output will be 15 tons.—*Chem. Eng. and Mining Review.*

A BRITISH ELECTRICAL PROVING HOUSE.

At a meeting of the Newcastle Local Section of the Institution of Electrical Engineers on May 13th, Mr. C. Turnbull read his paper on this subject. An abstract of the paper appeared in our issue of May 10th. At the conclusion of the paper he said that the question was one that Mr. Wordingham was paying great attention to, and it was the intention of the Council that something should be done. It was suggested that the National Physical Laboratory should do the work, and undoubtedly, he thought, that was the best body to do it. It was felt by manufacturers and others that the proving house should be British in its widest sense. If the idea were supported he had every hope that it would come into being.

Mr. J. J. Jackson said he thought there was a very strong reason why the proposal should go forward. No one doing work in factories could fail to realise the serious waste of time due to inferior material. There was a marked difference between old material and the more modern. Modern material was of little value mechanically, with the result that it had frequently to be replaced.

Dr. Thornton said he was sure they must support that proposal; it was a matter of life or death to have something of that kind. The National Physical Laboratory was the proper channel. He thought they were indebted to Mr. Turnbull for raising the question. Emphasising the need for such an institution, Dr. Thornton instanced the case of flame-proof lamps, and said that matter was not in a satisfactory position, for it was in the hands of the chemists, and he did not think that was quite the right thing.

Mr. H. S. Ellis also spoke in support of the suggestion. With regard to the larger manufactures the goods turned out, he thought, were fairly good, but with regard to the smaller work the case was different. He thought that to make the scheme effective they would have to have legislation. One of his difficulties was that he had no jurisdiction to inspect work in houses. When they were testing insulation they had no right to pull up a floor-board to see whether the work was all right.

Mr. Pinkney expressed the opinion that to have everything standardised would be a tremendous advantage to everybody. There might be three grades in some materials, suitable for the different classes of work.

Mr. W. Cross spoke in support of the idea of a proving house, but he hoped that in working out the details they would not make the cost of electrical installations so great that they would prevent the public using electricity, or drive those who wanted a cheap installation to foreign rubbish. They did not want enormous factors of safety, and he believed good material could be obtained, but there was a great deal of rubbish on the market. He believed that the bulk of faults were due to bad workmanship rather than bad materials. Large quantities of cheap German cable were guaranteed to conform with the C.M.A. specification. The principal objection to the scheme was that it would be of little use having the proving house unless they were going to enforce the use of the material that had been passed by it.

Mr. Carter said that the testing house would do something in popularising the rules and making their meaning clearer. It seemed to him that a proving house might tend to bring many things into the open for discussion so that rules would not be drawn up, as in the past, in a hole-and-corner manner.

Mr. Andrews said they would not get the State Departments to go to the Proving House unless it was compulsory. The Post Office had the most elaborate method of testing cables. He thought there was not much chance of an electrical proving house unless they had a proving house for all the main classes of engineering products.

Mr. Hunt thought it would go a long way if they could get the support of the insurance companies.

Mr. MacCall also referred to the need of legislation, but said it was possible to get things tested now, and people did not use the facilities that were available. If the test were made by someone independent of supplier or maker then, he thought, the test would be accepted as fair.

Mr. Fawsett was of opinion that in the testing of samples, extreme cost would have to be avoided. He hoped that in the development of the idea the manufacturers would not be allowed to have too much to say.

Mr. Simon said he took it that the real object of the proving house would be to certify that samples sent to it agreed with a certain specification, or that the piece of apparatus submitted was one which met a standard specified.

Mr. Vernier said there were three classes of work that a proving house might do. First there was the general question of research, such as determining the carrying capacity of cables; then there was the approval of specific designs, and then the testing of materials, and there was a difficulty in drawing a line as to how far they were to go.

Mr. Turnbull, in reply, said the idea was not new; it had been tried in America, and there they had had so much experience that he did not think they would have much difficulty in getting to work here. He did not think they would get legislation before they got a proving house—that was to say, an approved authority.

OPERATING TEMPERATURES IN LARGE A.C. GENERATORS.

In an article in the *Electrical World* of March 30th on the above subject, Mr. H. D. Stephens says one of the chief causes of insulation failure is excessive temperature, and heretofore it has been a problem of determining when the prescribed temperature limit is exceeded. When thermometers were used for this purpose the insulation apparently failed in some cases before the temperature limit determined by laboratory test was exceeded. This apparent disagreement was really due to the fact that the thermometers were not placed where the maximum operating temperatures occurred.

It has been possible to determine the maximum operating temperatures much more effectively by the thermocouple or exploring coil, which can be installed where the hot spots are expected to occur. In fact, they have been found so effective that their use is becoming standardised in all large-size alternators having a core width of 20 in., and in all machines wound for 5,000 volts or over.

The exploring-coil type of detector consists of a coil of wire having a high resistance. Any change in resistance will be directly proportional to the temperature change; hence, if the resistance and corresponding temperature are known, the temperature can be readily calculated. The exploring-coil type of detector developed by the Westinghouse Electric and Manufacturing Co. consists of fine copper wire, is approximately 5 in. long, and has about 30 ohms resistance. The resistance is measured by a simple Wheatstone bridge arrangement in which the detector forms one of the four resistance arms.

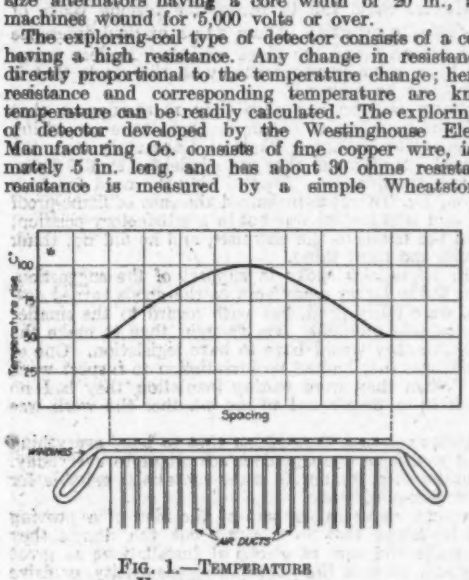

Fig. 1.—Temperature Variation along Armature Slot.

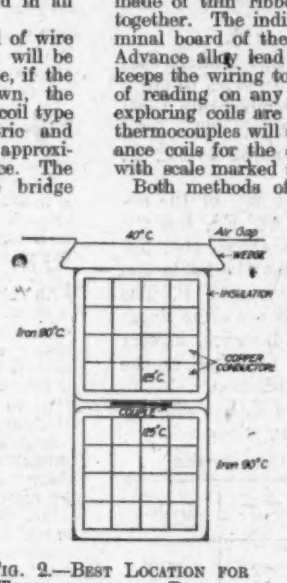

Fig. 2.—Best Location for Thermocouple to Detect Maximum Internal Temperature.

With this type of detector the readings will be absolutely accurate only when the temperature of the coil and leads is the same as that at which calibration took place. However, if the resistance of the coil is very high and the resistance of the leads relatively low, the percentage of error is very small indeed over the range of temperature found in practice. The fragility of the small exploring coil is its greatest drawback. If heavier wire were used for the coil, it would occupy more space in the slot, or the resistance would have to be made very much less. Further, even if only 5 in. in length, it measures an average temperature over this entire distance in the core. If the core is only 20 in. in width, the difference between the average and hot-spot temperature may be considerable, as the coil occupies 25 per cent. of the width. A large or longer coil will increase this percentage and render still greater the difference between the reading obtained and the actual "hot-spot" temperature.

The preceding disadvantages are absent with the thermocouple detector because the thermocouple registers the temperature at a single junction point, and it can be made of thin strong metal strips instead of very fine wire. The "hot" couple or junction point in the machine is at the point where the temperature is measured, and is connected to a "cold" couple in the temperature indicator. In the apparatus developed by one manufacturer this is a potentiometer of the galvanometer type arranged for switchboard mounting, and with the measuring scale calibrated to read directly in degrees Centigrade.

The temperature as indicated by either the exploring coil or the thermocouple is practically valueless as an indication of safe operating conditions unless the detectors are installed at the spots where the highest temperatures will occur. These spots are difficult to determine because the resultant temperature is due to several sources of heat, which may be widely different in different machines, even if of the same general type, especially when there is a change of load or terminal voltage.

In general, test data covering a large number of generators of different characteristics show the location of points of maximum temperature to be at or near the centre of the core and in the copper of the windings at this point. This is illustrated in fig. 1, which shows a temperature curve obtained by installing a number of detectors at various points across the machine, and all in the same armature slot.

The correct location for a detector in the armature slot is shown in fig. 2. Nearly all modern alternators have two-coil-per-slot windings. Therefore, if the copper has the highest temperature, any location except that between the two conductors gives a reading intermediate between the temperature of the copper and that of the iron, since the heat transfer from the hot to the cooler surface is accomplished only when a drop in temperature exists. When the two conductors in the same slot are at or near the same temperature, as they normally are, there is no tendency for heat transfer from one to the other, hence the detector at this point approximates the maximum temperature. Undoubtedly there are many large machines in service, equipped with temperature-indicating devices, whose temperature readings are absolutely valueless in so far as measurement of the "hottest spot" temperatures is concerned. This has been due to a lack of definite data on the subject.

Six thermocouples are ordinarily used per machine by the Westinghouse Electric & Manufacturing Co.; the couples are made of thin ribbons of copper and Advance alloy welded together. The individual copper leads are run from the terminal board of the machine to the switchboard. A common Advance alloy lead forms the other side of the circuit. This keeps the wiring to a minimum, and at the same time allows of reading on any one of the six couples employed. Where exploring coils are used the same wiring scheme as used for thermocouples will apply, except for the substitution of resistance coils for the couples and a standard type of voltmeter with scale marked and calibrated to read degrees Centigrade.

Both methods of measurement described are superior to the older thermometer method for machines having large ratings. The detector is useful at times of heavy load in furnishing the operator with data so that the safe temperature of the insulation may not be exceeded, and to check conditions of operation to predetermined loads.

Accumulations of dust and dirt in the air passages of the machine will, for a given load, cause the operating temperature to rise. The detectors will give indications as to when such conditions exist, and warn the operator to remedy them by cleaning the machine thoroughly. The use of detectors is not recommended for small-capacity machines, because such units are usually narrow of core, and have internal temperatures that differ but little from external accessible points. Furthermore, the armature slots are of such small proportions in these machines as to render the location of detectors either very difficult or impossible. Detectors cannot be used for measurement of temperatures of revolving fields of alternating-current generators, nor for revolving armatures of direct-current generators, because of the variable nature of the moving contacts and the large percentage of error that it would cause with such small values of current or voltage as are used in detector circuits.

WAR ITEMS.

A Reader's Appreciation.—A correspondent with the Royal Air Force in Egypt, who through a change in his department of "work" is now, to his delight, brought "into closer contact with matters electrical," says:—"Roll on the realisation of *the* big change for which we have hoped so long. Meanwhile, let me once more express my best thanks for what you are doing for us on service in keeping constantly in view what will be required of us all when this part of the strafe is finished."

The American Bosch Co.—It is announced from New York that the American Government has taken over the works of the Bosch Magneto Co. in the United States, and that in future the output of the factories will largely be used for American war purposes.

The Electrical Co., Ltd.—The Board of Trade has presented to the Court a petition for the winding up of this company. The petition is to be heard on May 28th. On the same day a similar petition is to be heard respecting the A.E.G. Electrical Co. of South Africa, Ltd.

Trading with the Enemy.—The "London Gazette" for May 17th contains further lists of persons and bodies in the following countries with whom trading is prohibited:—Argentina, Brazil, Chile, Colombia, Greece, Guatemala, Hayti and Dominican Republics, Netherlands, Netherlands East Indies, Norway, Persia, Portuguese West Africa, Spain, Sweden, and Venezuela.

A Halifax Roll of Honour.—The Roll of Honour, bearing the names of 289 employés of the Halifax Corporation Tramways and Electricity Departments, was unveiled on Tuesday evening last week by the Deputy-Mayor (Ald. R. Hodgson), at the club rooms of the Tramwaymen's Social and Benevolent Society, in Town Hall Street East. Mr. W. M. Rogerson, who presided, mentioned that of the men who had gone to the Forces 37 had been killed in action, 10 were missing, 38 had returned to civilian employment on discharge, three had gained the Distinguished Conduct Medal, and four had received the Military Medal.

Appointments Board for Demobilised Professional Men.—The report of the Committee appointed to consider the re-settlement of officers has been approved by the Minister of Reconstruction, and in accordance with its recommendations the Minister of Labour is proceeding to set up a department to be known as the "Appointments Department," in order to provide advice and assistance to officers and others requiring professional and business appointments on their return to civil life. The headquarters offices of the department will be at Gresham House, Old Broad Street, E.C. 2, and will be under the direction of Mr. C. H. McCall. The department will be represented in the provinces by branch offices.

The Professional and Business Register of the Ministry of Labour and the Officers' Technical Training Courses of the Ministry of Munitions will be merged in the new department. With it will be associated two Committees, one dealing with questions affecting appointments, and the other with questions of training. The former Committee will comprise representatives of the principal professional and business organisations, together with representatives of ex-officers and of the Government Departments concerned. Local committees similarly composed will be associated with the department's provincial offices. The Training Committee will be an inter-departmental committee jointly appointed by the Ministry of Labour and the Educational and other Departments interested, including the Board of Agriculture and Ministry of Pensions, and the chairman will be nominated by the Board of Education. It will contain representatives of the universities and other educational organisations, as well as representatives of commerce and industry. With the advice and assistance of these Committees the Department will endeavour to find suitable appointments of a professional and business character for ex-officers and others requiring them, and either directly, or through the Educational Departments, will also endeavour to arrange facilities for those who wish to undergo courses of instruction either of a general or technical character.—*Labour Gazette.*

Defence of the Realm Tramway Regulations.—The following Order has been made under the Defence of the Realm Act:—

"7BC. If in the case of any tramway undertaking carried on under statutory powers by a local authority it appears to the Board of Trade that it is necessary for the successful prosecution of the war that the undertaking should be carried on in an efficient manner, but that owing to circumstances arising out of the war it cannot be so carried on without either charging tolls, fares, and charges in excess of those which the local authority is authorised in any year to charge or without applying in aid of a deficiency in any year in the revenue of the undertaking, local rates, or funds which are not applicable to that purpose, the Board of Trade may by Order authorise the local authority to charge the local rates or funds with any such deficiency and to defray the deficiency thereout to such extent and subject to such conditions as may be specified by the Order, and may by such Order modify any local Act regulating the undertaking to such extent and during such period as appears to the Board necessary for the purpose aforesaid, or for the purpose of relieving the local authority from the obligation of making allowances for renewals or depreciation."

Exemption Applications.—Hastings Tribunal has given three months' exemption to A. Watson (Grade 3), a fitter with the Tramway Co.

At Colchester, the Essex Appeal Court refused a National Service appeal against exemption held by B. W. Southgate (41, Grade 2), electrician with Joslins, Ltd., of Colchester.

Kington (Herefordshire) Rural Tribunal has granted exemption until July 1st to F. W. Hextall (32, Grade 1), estate electrician.

Conditional exemption has been granted to R. Down (41), meter inspector with the Folkestone Electric Light Co.

The Ilfracombe Tribunal has refused further exemption to G. Dring, electrical engineer, appealed for by Mr. H. J. Stewart, manager of the Electric Light Co.

The Widnes Tribunal has granted three months' exemption to an electrician (21, Class A), the sole support of a widowed mother. He failed to enter the Flying Corps early in the war.

At Windermere, Mr. C. Walker, manager of the Electricity Supply Co., appealed for the retention of J. Thornborough (C 2), electrician. The National Service Representative did not press his opposition owing to the man's category, and the fact that the staff at the works was already sufficiently depleted. Three months' temporary exemption was granted.

At Canterbury, an appeal was made by S. Terry (29, A 1), electrician, St. Dunstan's, whose protection certificate had been withdrawn by the Munitions Area Recruiting Officer. It was stated that outside the Corporation electric light works he was the only qualified electrical engineer in the city. For the Military, it was contended that the Tribunal could not consider any question of certified occupation; only any ground of hardship. Mr. Terry's leave could be arranged, and he could easily resell his stock. For the appellant it was urged that the business could not be re-established later on. Three months were conceded.

At Chatham, the Tribunal dealt with 38 employés of the Tramway Co., the National Service Representative asking that their conditional exemption should be cancelled, letting them rely on their cards of protection. For the company it was stated that they objected on principle; if the men lost their exemption from the Tribunal, they would lose the right of appeal. The managing director, Mr. W. Jensen, said that he had repeatedly tried to find substitutes, but his efforts were unsuccessful and discouraging. The men sent to him by the Labour Exchange were absolutely unreliable as motormen. Men who had been wounded could not stand the strain, and wanted to sit down, and became giddy, and the company had to study the public. Two old drivers were now employed in barracks as messmen, and he had tried to get them back. It was decided that the exemptions should stand, and notice of appeal was given.

On a review, the Eastbourne Tribunal has cancelled conditional exemption held by J. E. Aldridge (B 2), cable foreman in the Corporation electricity works, and has substituted six months, with re-grading.

At Stratford-on-Avon, the National Service Representative appealed against exemption, subject to substitution, given to A. Baldwin (41, Grade 2), electrician to Mr. J. Fielden, Kineton. Capt. Wratislaw stated that a qualified substitute sent by the Labour Advisory Committee had been refused. Mr. Fielden stated that the substitute offered was in no way suitable, and if the Red Cross Hospital was to be carried on it was only reasonable that such a man as Baldwin should be retained to see to the lighting, &c. The Tribunal decided that a suitable substitute had not been offered, and they confirmed the exemption.

At Broadstairs, the Isle of Thanet Electric Traction Co., Ltd., appealed for a number of indispensable employés, and two were given conditional exemption, subject to substitution.

A review has been made of the case of A. C. Cooper (35, Class A), stoker, dynamo attendant, &c., at the Isle of Wight County Asylum. The engineer (Mr. Holt) said that he could not spare another man, and if the engines stopped there would be no electricity or water for the institution. He now had only six men instead of the normal staff of 14. A month was granted with a view to substitution.

At Worcester, the Tribunal has withdrawn a certificate of exemption held by J. Harris (40, A 1), public lamp attendant and emergency hand, engaged at the Corporation electricity works.

At Reigate, the East Surrey Traction Co. appealed for W. P. MacAlpine (38), electrician and fitter, and J. Godbold (39), driver, and, with the assent of the National Service Representative, each was given three months' temporary exemption.

An application was made to the Fulham Tribunal regarding the cancellation of a certificate of exemption granted to a steam boiler driver and electrician, aged 31, married, Grade 1, employed by Messrs. Wm. Whiteley, Ltd., West Kensington. Conditional exemption was granted in August, 1916, but the certificate was recently cancelled by the National Service Representative under the new Order. The Chairman inquired if the Tribunal had any power in the matter. The firm's representative contended that the certificate had not properly been cancelled, because, he submitted, the National Service Representative had no power to cancel it, the man concerned being the only one of his occupation in his shift. The Chairman said he failed to see how the case came under the new Order, but if it did the Tribunal had no jurisdiction. No action was taken.

Messrs. Marbro, Ltd., manufacturers of electrical switches, of Fulham, applied to the local Tribunal for the renewed exemption of Mr. W. A. Robertson, 39, married, the general manager and secretary of the company. It was stated that the company was formed in 1914 for the purpose of making certain electrical appliances which up to that time had been a German monopoly. Mr. Robertson was not only the manager, but the sole male employé, and was absolutely indispensable, the directorate being merely an advisory body. It was claimed that this was the only business of its kind in London. The Tribunal renewed the certificate for four months.

At the Shoreditch Tribunal, Messrs. Mortiz & Chambers, Ltd., of 89, Great Eastern Street, E.C., importers of electrical goods from Japan and America, appealed for Robert Lambert Chambers, aged 37 years, classed "A," governing director, for the fifth time. It was stated that they imported globes for electric lights under licence, space being allowed on board steamers according to their pre-war imports. Mr. Chambers managed the finance, in fact was the only one who could do so, as Mr. Moritz had had a paralytic stroke, and only came to the office occasionally, whilst Mr. Kipling, the other director, was only in a consultative position. Mr. Chambers and the family held stocks to the value of £9,000. The Tribunal decided to grant four months exemption.

LEGAL.

Tampering with Electricity Supply Wires.

At St. Augustine's Petty Sessions, recently, two youths, S. T. Davy and F. Anderson, were summoned for unlawfully and wilfully doing damage, injury, and spoil to and upon certain cable, the property of the Whitstable Electricity Supply Co., Ltd., to the amount of 1s., on May 1st. From the evidence it appears that on the date mentioned the electric light over a considerable part of the town went out at about 8.45 p.m. The places affected included the Military Hospital at Tankerton, where there was X-ray apparatus. The next morning the company was inundated with complaints, and there was a certain loss of revenue. There was alarm and apprehension among the public, who thought there was an air raid. Subsequent inquiries showed that a piece of wire had been thrown across the cable in Cromwell Road, at a place near to the residence of the defendant Davy. The boys were charged with throwing the wire upon the cable. It did not matter what their intention was, said the Supply Co., the effect was the thing. This was not an isolated case. The same sort of thing had happened both before and since May 1st, though it was not contended that these boys did it all. The company asked the Bench to put a stop to such proceedings. The Bench decided that there was no case against Anderson. The solicitor for Davy explained that the latter had a "little knowledge"—a "dangerous thing"—about electricity, and he wanted to produce a spark. He succeeded in doing so—produced a tremendous one. He and the other lads with him were then afraid of what had happened, and ran away. Davy denied doing it, but a police representative managed to entangle him and the other boys in their talk. Davy had now been sufficiently frightened. The Bench fined him 10s., including costs, and probably he has also been "dealt with" by father.

Electrical Engineer Fined.

At Sutton Coldfield, on Thursday last week, George Robert Coles, an electrical engineer, of Sutton Coldfield, was fined £10 for fraudulently consuming electricity, the property of the Corporation, within the last six months.

Mr. Thomas Bloore, the Corporation electrical engineer, said the defendant was using electricity freely. He went to his house on the 7th, and found that the wiring in the pantry, connected with the electric meter, was so arranged that the current supplied to the premises was not passing through the meter. Several alterations had been made to the electrical fittings of the house, and these had not been reported to the electrical department.

When asked for an explanation, Defendant stated that the wire fell out of the meter, and, in order to get a light, he had placed it in the opposite terminal, and had forgotten to report the matter.

TRADE STATISTICS OF BRAZIL.

The following figures show the imports into Brazil of electrical and similar goods during the year 1916. The figures for 1915 have been added for purposes of comparison, and notes of increases or decreases, as the case may be, are given:—

	Dollars. 1915.	Dollars. 1916.	Dollars. Inc. or dec.
Electric cable.—			
From United States ...	203,000	342,000	+ 139,000
,, Great Britain ...	1,000	9,000	+ 8,000
,, Other countries ...	5,000	5,000	—
Total	209,000	356,000	+ 147,000
Insulators.—			
From United States ...	21,000	53,000	+ 29,000
,, Great Britain ...	4,000	17,000	+ 13,000
,, Other countries ...	5,000	5,000	—
Total	33,000	75,000	+ 42,000
Other electrical machinery.—			
From United States ...	461,000	876,000	+ 415,000
,, Germany	22,000	—	- 22,000
,, Great Britain ...	137,000	128,000	- 9,000
,, France	29,000	37,000	+ 8,000
,, Other countries ...	42,000	85,000	+ 43,000
Total	691,000	1,126,000	+ 435,000
Electric motors.—			
From United States ...	40,000	42,000	+ 2,000
,, Germany	7,000	—	- 7,000
,, Great Britain ...	13,000	28,000	+ 15,000
,, Switzerland ...	5,000	40,000	+ 35,000
,, Other countries ...	14,000	13,000	- 1,000
Total	79,000	123,000	+ 44,000
Dynamos and electrical generators.—			
From United States ...	7,000	43,500	+ 36,500
,, Great Britain ...	18,000	7,000	- 11,000
,, Switzerland ...	6,000	26,000	+ 20,000
,, Other countries ...	9,000	6,500	- 2,500
Total	40,000	83,000	+ 43,000
Industrial machinery.—			
From United States ...	111,000	288,000	+ 177,000
,, Great Britain ...	361,000	315,000	- 46,000
,, Germany	13,000	—	- 13,000
,, France	19,000	54,000	+ 35,000
,, Other countries ...	47,000	101,000*	+ 54,000
Total	551,000	758,000	+ 207,000
Lighting apparatus.—			
From United States ...	32,000	72,000	+ 40,000
,, Germany	6,000	—	- 6,000
,, Great Britain ...	23,000	18,000	- 5,000
,, Other countries ...	11,000	9,000	- 2,000
Total	72,000	99,000	+ 27,000
Other machinery (except textile and agricultural).—			
From United States ...	551,000	936,000	+ 385,000
,, Great Britain ...	371,000	331,000	- 40,000
,, Germany	37,000	—	- 37,000
,, France	123,000	97,000	- 26,000
,, Belgium	1,000	3,000	+ 2,000
,, Italy	21,000	21,000	—
,, Switzerland ...	37,000	82,000	+ 45,000
,, Holland	96,000	—	- 96,000
,, Other countries ...	92,000	132,000	+ 40,000
Total	1,329,000	1,602,000	+ 273,000
Motors, gasoline, kerosene, &c.—			
From United States ...	21,000	41,000	+ 20,000
,, Great Britain ...	5,000	8,000	+ 3,000
,, Switzerland ...	22,000	15,000	- 7,000
,, Other countries ...	9,000	150,000	+ 141,000
Total	57,000	214,000	+ 157,000
Steam engines.—			
From United States ...	2,000	2,000	—
,, Great Britain ...	1,000	11,000	+ 10,000
,, Other countries ...	2,000	4,000	+ 2,000
Total	5,000	17,000	+ 12,000
Motors, n.o.e.—			
From United States ...	23,000	40,000	+ 17,000
,, Great Britain ...	40,000	16,000	- 24,000
,, Sweden	14,000	19,000	+ 5,000
,, Switzerland ...	6,000	32,000	+ 26,000
,, Other countries ...	16,000	4,000	- 12,000
Total	99,000	111,000	+ 12,000
Telegraph and telephone posts, and bridge and fence material.—			
From United States ...	41,000	52,000	+ 11,000
,, Great Britain ...	91,000	73,000	- 18,000
,, Germany	1,000	—	- 1,000
,, Other countries ...	5,000	—	- 5,000
Total	138,000	125,000	- 13,000
Copper wire.—			
From United States ...	57,000	85,000	+ 28,000
,, Great Britain ...	8,000	8,000	—
,, Other countries ...	3,000	4,000	+ 1,000
Total	68,000	97,000	+ 29,000
Iron and steel wire.—			
From United States ...	607,000	1,633,000	+ 1,026,000
,, Germany	17,000	—	- 17,000
,, Great Britain ...	51,000	59,000	+ 8,000
,, Other countries ...	63,000	102,000	+ 39,000
Total	738,000	1,794,000	+ 1,056,000
Hydraulic pumps and accessories.—			
From United States ...	42,000	56,000	+ 14,000
,, Great Britain ...	25,000	11,000	- 14,000
,, Germany	5,000	—	- 5,000
,, Other countries ...	13,000	24,000	+ 11,000
Total	85,000	91,000	+ 6,000
Scientific instruments.—			
From United States ...	27,000	48,000	+ 21,000
,, Germany	11,000	—	- 11,000
,, France	9,000	20,000	+ 11,000
,, Great Britain ...	14,000	20,000	+ 6,000
,, Other countries ...	17,000	12,000	- 5,000
Total	78,000	100,000	+ 22,000
Electric lamps.—			
From United States ...	98,000	237,000	+ 139,000
,, Great Britain ...	17,000	14,000	- 3,000
,, Holland	48,000	40,000	- 8,000
,, Other countries ...	33,000	21,000	- 12,000
Total	196,000	312,000	+ 116,000

*Sweden, $35,000.

BUSINESS NOTES.

Dinner. — The Telephone Assembly Section of the Apparatus Department of Siemens Bros. & Co., Ltd., Charlton, held a dinner at Woolwich, last Saturday week, at which a proposal was put forward for forming an association to promote social intercourse. It was intended to present £15 to an employé who had suffered a long illness, but she was not able to be present.

Aluminium in Austria-Hungary. — It was recently reported from Vienna that the Austrian Government had acquired boring rights relating to large districts in the Istrian peninsula and Dalmatia, and intended to open up the deposits of bauxite there ascertained by geologists to exist. On the other hand, it was said that a scheme was being promoted in Dalmatia to establish a large aluminium works, in the constitution of which, besides three Vienna banks, the German Berndorf Metal-ware Works, the firm of Krupp, and the Kerka Hydraulic Co. were to participate. It is now stated that negotiations in regard to the formation of a large private aluminium works in the district of Bihar (Hungary) have failed to mature. The Government consequently intends to proceed with the erection of the works, with a slight participation of private capital, at an expenditure of from £1,250,000 to £1,666,000.

Liquidations.—British Adding Machine Co., Ltd.—Meeting, June 21st, at 1 and 2, Great Winchester Street, E.C., to hear an account of the winding-up from R. L. Sare, liquidator.

"Electrician" Printing and Publishing Co., Ltd., London.—Voluntary liquidation, with Mr. E. C. Elliott, 4 and 6, Throgmorton Avenue, E.C. 2, as liquidator. The business, it will be remembered, was taken over by Messrs. Benn Bros., Ltd.

Elieson Electric Traction Co., Ltd.—As the company is unable to pay its debts, &c., it is winding up voluntarily, with Mr. J. T. Lillhardt as liquidator. Meeting of creditors May 30th, at 25, Finsbury Square, E.C.

Auxiliary Electrical Co., Ltd.—Meeting at Salisbury House, London Wall, E.C., July 1st, to hear an account of the winding up from the liquidator, Mr. F. R. Reeves.

Japan and Australian Trade. — Prof. Murdoch, of Sydney University, thinks it likely that large numbers of young Japanese who went abroad, mainly to America, to study trade, will be attracted to Australia.

Book Notices.—"The Year-Book of Wireless Telegraphy and Telephony, 1918." lxxxiv + 1,154 pp. London: The Wireless Press, Ltd. Price 6s. net.

"*Journal* of the Institution of Electrical Engineers." Vol. LVI. May, 1918. No. 274.—The May issue contains the following paper:—"The Control of Large Amounts of Power," by Mr. E. B. Wedmore. Also Report of the Council for 1917-18, and the annual and Benevolent Fund accounts for 1917.

Decimal Money Tables. By A. M. Pooley. London: Syren and Shipping, Ltd. Price 2s. 6d. net.—This set of decimal exchange tables, covering the conversion of British sterling from and into any foreign money at any rate of exchange, and to any amount, has been published in past years as a section of the *International Mercantile Diary and Year Book* issued by "The Syren and Shipping"; in view of the expected adoption of decimal coinage, the tables are now published in separate form. They are very complete and comprehensive, and even under existing conditions will be found of great use; many firms have already adopted the practice of keeping their books in decimalised pounds, and have derived considerable advantages therefrom, and these tables greatly facilitate the process of conversion for this purpose. They are clearly printed and conveniently arranged, and are carried out to a degree of accuracy ample for all purposes.

Bankruptcy Proceedings.—R. E. Connold, late electrician, now R.N.A.S., Canterbury.—Application for discharge, to be heard June 11th, at Canterbury.

Trade Announcements.—The Tudor Accumulator Co., Ltd., have disposed of their rail-welding business to the managing director (Mr. Edwin Jacob), who is continuing the business on his own account, with the same experienced engineering staff, as the Rail-Welding Co., at 119, Victoria Street, S.W. 1, and will attend to debts, &c. Mr. Jacob will continue as managing director of the Tudor Accumulator Co., Ltd.

Mr. Joseph Oxley has removed his head office from Vicar Lane to Cadman Chambers, Norfolk Street, Sheffield.

The Government having temporarily requisitioned the Caxton House offices of Brunner, Mond & Co., Ltd., their address is now 82, Victoria Street, S.W. 1.

Cooking Apparatus Prices.—Messrs. Belling & Co. announce that as from May 16th their list prices are subject to an increase of 50 per cent., with the exception of their electric fires, which are advanced by 33⅓ per cent.

LIGHTING AND POWER NOTES.

Accrington.—Year's Working.—The accounts of the Corporation electricity department for 1916-17 showed a loss of £10.155, but in the year just ended this deficit has been turned into a profit of £2,169. The installation of a steam turbine, with a resulting economy in the cost of production, a considerable saving in the consumption of coal, and the increase in electricity charges have been the chief factors. At the beginning of the last financial year there was a total deficiency on the department of £14,521, the result of losses in previous years, which was temporarily provided for by contributions from sums in hand in connection with the general district fund and contributions from the rates, leaving a deficiency of £2,661, which is reduced by this year's profit to £491.

Australia.—Price Increase.—The Melbourne City Council has decided to increase the charges for electricity for lighting as follows:—4d. per unit for the first 50 units consumed per month, 3½d. per unit for the next 1,000 units, 3d. per unit for the next 1,000 units, and 2d. per unit for the remainder of the units consumed per month; for power in excess of 5,000 units per month, an additional monthly charge of 0·045d. per unit for every 2s. 6d. increase above 20s. per ton in the average price of coal delivered.

Sydney City Council decided that, owing to the generating plant being loaded to its full capacity, no new consumers would be connected after the end of March. The Council has arranged to obtain a limited supply of electricity from the Government tramway power house at White Bay, but until converting plant is installed this cannot be taken advantage of. The converting plant is expected to be in operation by September 1st.—*Tenders.*

Surplus Power.—The question of the disposal of the surplus power from the Victorian Railway Commissioners' Newport power station has been satisfactorily settled. The Melbourne City Council and the Melbourne Electricity Supply Co. have agreed to an arrangement under which the Commissioners will supply electricity to Footscray (including Footscray tramways), Williamstown, and the neighbouring districts. Any surplus power will be at the disposal of the Melbourne City Council and the Electric Supply Co.; under the original proposal, the Commissioners were not restricted as to area.—*Tenders.*

Electric Steel Production.—The Sydney City Council Electric Lighting Committee, says *Tenders*, has received a report from the city electrical engineer with reference to the inquiry from the Commonwealth Steel Products Co. as to on what terms and hours the Corporation would supply power for electric steel production. The engineer states that the company has now completed an arrangement by which its works will be established in Newcastle, and will get its supply of electricity from the Railway Commissioners' power house at Newcastle; this is regrettable, as the electric light department of the Council has lost a valuable customer, who would eventually have become highly profitable; secondly, the industry of making steel in electric furnaces, which might have been established in Sydney to the profit of the Sydney community, will now probably be permanently established in Newcastle; also, as a result of the arrangement made between the Steel Co. and the Railway Commissioners, one of the large turbo-alternators from White Bay will be moved to Newcastle, and this must greatly reduce the surplus electricity which the Commissioners might have supplied to the City Council, and which the Council might have used for the next few years, until the Council's new generating plant was installed.

Bury St. Edmunds. — Messrs. Boby, Ltd., having declined the offer of the T.C. to supply power and lighting at 2d. per unit for a consumption of 150,000 units per annum for five years certain, the Corporation has decided that it cannot see its way to make any further concession. The engineer had suggested a final offer of 1½d. per unit.

Continental.—Spain.—In order to meet the increasing demand for electricity, the Sociedad Electra Valenciana, of Valencia, has recently added 3½ miles to its low-tension mains and nearly 2 miles to the high-tension system, bringing the totals up to 45 and 11 miles respectively. Three new transformer stations have lately been established in the town, and six more are shortly to be provided. At the present time the company is supplying energy to 14,400 consumers.

Derbyshire. — Linking-up Scheme. — A meeting of representatives of the coal, iron, and steel industries of Notts. and Derbyshire was held on Saturday, at Mansfield, to discuss the Government proposals for the unification of electrical supply in the Notts. and Derbyshire district, and to consider the advisability of linking-up with the South Yorkshire scheme. Mr. A. B. Gridley, the chief electrical officer of the Ministry of Munitions, attended, and addressed the meeting, and subsequently a Committee was elected to present a scheme of electric supply for the district similar to that adopted by the Nottingham Corporation. It was also decided to engage an expert to present a report on the matter.

Edinburgh.—A number of resolutions have been adopted by the Corporation Electric Lighting Committee, among which are several dealing with the existing arrangements for the generation and distribution of electric power supply in the country. It was suggested that when the areas for the super-stations were decided upon Edinburgh should be one, and that the power should be supplied from the Portobello station. The necessity of the erection of the new Portobello station being proceeded with was also emphasised. These resolutions will come before the Council, which will be asked to appoint a deputation to go to London and press upon the authorities the urgency of the matter.

Fleetwood.—Year's Working.—The electricity undertaking of the U.D.C. for the past year shows a deficit of £2,181, notwithstanding the increased charges for energy. The expenditure has been £9,376 and the income £7,195.

Galway.—The Electric Light Co. has intimated to the U.C. that it does not propose to offer its works for sale, as had been assumed in a recent discussion.

Grimsby.—War Bonus.—Having refused an additional war bonus to the clerical staffs, the Corporation Electric Lighting Committee has received notice from the National Union of Clerks that, in view of the 12½ per cent. award upon earnings, they have applied for the matter to be referred to arbitration.

Harrogate.—Year's Working.—The financial statement for the past year shows that the income of the electricity department, after allowing for capital charges to revenue and reserve, was £757 better than the estimate.

Huddersfield.—Price Increase.—The Electricity Committee has decided that the charges for energy for power and lighting to ordinary consumers shall be increased from 25 per cent. to 37½ per cent. above pre-war charges.

Hull.—Wages.—The Electricity Committee has had a request for an increase of wages from the girls employed in reading meters and other girls at the power station. The acting engineer (Mr. McGoris) stated that the girls did not work the same hours, nor do the same work as the men, and they were paid 26s. a week plus the bonus. The request was not entertained.

Breakdown.—The firing of a fuse-box on the Holderness Road caused a partial breakdown in the electric supply in East Hull, on Whit Monday. The Holderness Road tramcars and also the supply to private houses and at the East Hull places of amusement were involved. A Corporation employé who opened a street fuse-box was burned about the hands and face, and required treatment at the infirmary.

London.—Shoreditch.—Bulk Supply.—The Electricity Committee reports that the existing agreement for a bulk supply of electricity from the Stepney B.C. Electricity Department expired last September, but the supply has been continued, subject to the terms being revised. As the result of the conference between the respective borough electrical engineers, the Stepney B.C. has intimated its willingness to continue the bulk supply until the end of September, 1918, on the same terms, with the exception that the charge per KW. be increased by 5s. per KW. The Committee recommends that, subject to the consent of the B. of T., the offer be accepted.

Lambeth.—Street Lighting.—The B.C. has decided to request the Home Office to consider the question of a further reduction in street lighting during the summer months, and has invited the other Metropolitan Borough Councils to take similar action. The Public Lighting Committee was requested by the Council to consider the advisability of not lighting the public lamps in certain streets during the summer months, but it found it could take no action, as the question of street lighting was now entirely in the hands of the Home Office.

Musselburgh.—Price Increase.—The T.C. has authorised the Electric Light and Traction Co. to increase its charge for domestic electric lighting from 5d. to 7d. per unit for the duration of the war, and a reasonable period thereafter.

Nelson.—Wages.—The Electricity and Tramways Committee has declined to grant an application by the Burnley and District Joint Engineering Trades Societies for improved working conditions and increases of wages for certain employés in the electricity department.

Newport (I. of W.).—Price Increase.—The T.C. has decided to withdraw opposition to the application from the E.L. Co. to increase the maximum price of energy to 9d. per unit, on the company agreeing not to charge any consumer higher than 8d. without the consent of the Corporation.

Rawtenstall.—Bulk Supply.—As the result of a conference, last week, between representatives of the Bacup and Rawtenstall Corporations, a satisfactory agreement was arrived at with respect to the terms for the supply of electricity in bulk by Rawtenstall to Bacup for the current period of five years, concerning which serious differences had arisen.

Spenborough.—Year's Working.—There is an estimated loss on the Council's electricity undertaking of £1,000, requiring a subsidy of a 2d. rate.

Stafford.—Year's Working.—A balance of £3,542 on last year's accounts of the Corporation undertaking has been absorbed in the payment of loan charges and income-tax, except for £100 transferred to reserve.

South Africa. — Johannesburg. — According to the *Globe*, the electricians' strike has ended, the Council having conceded the power station engineers' demand for £8 2s. weekly, an increase of 12s. per week.

TRAMWAY AND RAILWAY NOTES.

Belfast.—12½ per cent. Bonus.—The impasse created in the Corporation's tramway service by the opposed requirements of the "Aberdeen Clause" in the Act of 1904, under which the system was acquired from private owners, and the 12½ per cent. award given the employés, seems to be solved, the Government having taken steps to release the Corporation from the obligations imposed upon it by the "Aberdeen Clause," which compels the tramways to be self-supporting. The Corporation found itself in the extraordinary position that if it failed to enforce the clause it broke the law; if it failed to enforce the law it broke the award—in either case a very serious matter for it. The revenue returns show that with the maximum fares in force, and the cutting down of expense in every way and the reduction of the service, there is still a deficit of over £20,000 to be met. With the increased wages of 12½ per cent., there is a deficit of over £56,000 to be met, and with the "Aberdeen Clause" abrogated there will still be a deficit of £32,000 to be met by the ratepayers, who in return have a worse service, and last week were threatened with a total shut down of the system. This would have been a serious matter, as over 56,000 workmen engaged in national work are conveyed daily to the various shipbuilding yards, &c. The employés are on notice, which will expire on the 23rd inst. Last Saturday the cases, which involve 880 employés, were again heard by the Munitions Tribunal, and adjourned till the 29th inst., on the understanding that the arrears accruing under the award will be paid to the men by the end of this month.

Blackpool.—Annual Estimates.—Having considered its estimates for the current year, and in view of further restrictions on traffic by the Government, the Tramway Committee estimates that the net profit will be £15,000, as compared with an actual profit of £31,518 for the year just ended. The estimated income is £100,000 (as against £119,339 for the past year), and the estimated expenditure £65,500 (being £3,000 less than the actual expenditure for the past year), leaving a gross profit of £34,500 (as compared with £50,883 for the past year).

Bolton.—Sunday Services.—The Corporation proposes commencing the Sunday tramway service at 1.30 p.m., instead of 12 noon, and also to curtail the week-night service. Southport Corporation has decided not to run cars before 2 p.m. on Sundays.

Continental.—Sweden.—The Swedish Postal Authorities are about to make some trials of an electric motor delivery van in connection with the collection and delivery of letters.

Edinburgh.—Prov. Order.—The Corporation has made application to the Secretary for Scotland for a prov. order to construct new tramways and to reconstruct existing tramways for working by electricity or other mechanical power.

Tramway Managership.—The Tramway Committee has decided, in view of the taking over of the tramways by the Corporation, that it is desirable to appoint a manager, at a salary of about £1,000 per annum.

Edgware and Hampstead Railway.—The B. of T. has extended for one year the time for the completion of certain works, purchase of land, &c., in connection with the construction of this railway.

Huddersfield.—Year's Working.—The total income of the tramway undertaking for the year ending March 31st last amounted to £174,292, as compared with £152,436 last year. The surplus amounted to £7,462, as against £9,844 for the previous year, £6,750 being allocated to the relief of the rates, and £712 transferred to the reserve and renewals account, which now amounts to £60,692.

Leeds.—Parcels Service.—The tramway parcel carrying department, recently established, is to be considerably extended very shortly, and it is stated that traders are to be offered a special inducement to use the system by an arrangement of a 5 per cent. discount on parcel stamp purchases in lots of £5 or over, and, where desired, monthly accounts may be opened.

London. — Women Conductors.—According to the *Tramway and Railway World*, Mr. L. E. Harvey, general manager of the Ilford Tramways, has been notified by the Commissioner of Police that all inquiries as to women applicants for tramway car conductors' licences should be made by the police instead of by the tramway officials. It appears that in September, 1915, when women conductors were first employed, the Chief Commissioner of Police agreed with all the managers of the metropolitan tramways that the latter should make all inquiries as to character, age, &c., and that on the manager's certificate the police would issue a licence. Now, for no stated reason, this arrangement has been rescinded, after having worked satisfactorily for nearly 2½ years. Mr. Harvey has addressed a letter of protest to the Commissioner, pointing out that there was no reason for the alteration, and that, bearing in mind the considerable extra duties of the police at the present time, the proposed arrangement would greatly delay the issue of licences.

Mexico.—The company owning the electric street car system of Mexico City and its suburbs has established a Committee of Justice, before which all persons having complaints against employés of the lines are invited to appear and present their charges. Several hundred such cases have already arisen, and the findings of the Committee are enforced by the company. There are over 3,000 employés on the various lines of the system.

Nelson.—Fare Revision. — At the T.C. meeting, last week, Mr. W. F. Cooke, chairman of the Electricity and Tramways Committee, in referring to the decision of the Committee to abolish ½d. fares, stated that the Committee was paying more than £1,150 in wages over what was paid before the war, and for the ensuing year it was faced with an additional advance, which meant another £1,000. Nelson, he added, was the last borough in the whole of England to abolish ½d. fares.

Padiham.—The U.D.C. has decided that a report be prepared upon the position of the Council with respect to the tramways within the urban district, and submitted to a special meeting of the General Purposes Committee.

Preston.—WORKMEN'S FARES.—The Corporation proposes discontinuing the present workmen's fares, and to charge workmen single fare for return journeys.

TELEGRAPH AND TELEPHONE NOTES.

Holland.—Java and Holland are now in communication by wireless over a distance of 10,000 miles. The station at Bandoeng, Java, is transmitting 5,000 words daily to Scheveningen, near The Hague. It is 2,800 ft. above sea level.—*T. and T. Age.*

Rumania.—According to a Reuter telegram, referring to the fact that Germany, under the peace treaty, has assured to herself possession of the telegraph lines, wireless installations, and cable system on the Rumanian coast, the *Reichspost* says that these measures are connected with a plan for a big German intelligence service after the war, particularly in the wireless domain.

Germany has secured permanent telegraphic communication with Turkey *via* Rumania, the right to make the fullest use of all telegraphs in Rumania, and, until the year 1950, a cable station on what remains of the Rumanian coast.—*The Times.*

Sweden.—According to advices from Stockholm, the Swedish Telegraph Administration has made representations to the Government with regard to the reorganisation of the radio-telegraph service, especially in the matter of installations on mercantile ships. Hitherto the shipowners have been compelled to apply to the international company—the Société Anonyme de Télégraphie sans Fil of Brussels—which is said to be the owner of the working rights for Sweden of both the Telefunken and the Marconi systems. The tendency of this company is declared to lie in the direction of endeavouring to bind the shipowners also for the future when the patents expire, so as to be able to retain its monopoly in this respect. The Telegraph Administration considers that the letting out on hire of ship installations should be taken over by the Administration, and after negotiations with the Elektriska Aktie Bolaget A.E.G. of Stockholm, which represents the licensee company mentioned, has entered into an agreement for the delivery of 0·5-KW. installations on the Telefunken system for the account of the Telegraph Administration. The Administration intends to invite Swedish shipowners to subscribe for such installations in the same manner as in the case of telephone exchanges. Stations for ocean-going vessels, with plants of from 1 to 2 KW., will be dealt with later.

Wireless Strike.—The wireless operators are threatening to strike if their wages grievances are not remedied.

CONTRACTS OPEN AND CLOSED.

OPEN.

Australia.—BRISBANE.—July 1st. Treasury. Steam-driven turbo-alternators, boilers, and boiler-house equipment for the Inkerman irrigation area near Townsville, N. Queensland. Under-Secretary, the Treasury, Brisbane.

MELBOURNE.—July 3rd. Victorian Railways Department. Electric meters for power circuits. Chief Storekeeper, Railway Offices, Spencer Street.

Belfast.—May 31st. Electricity Department. 9,000 yd. of 6-core 0·1 sq. in. lead-covered, paper-insulated cable and laying. See "Official Notices" to-day.

Erith.—Electricity and Tramways Department. 500-KW. rotary converter with transformers, switchgear, &c. See "Official Notices" May 18th.

London.—ISLINGTON.—May 24th. Lighting Committee. 5,000-KW. turbine, alternator, exciter, condensing plant, switchgear, piping, &c., water-tube boiler, coal conveyer, telpher, burners, steam piping, &c. See "Official Notices" April 19th.

Newcastle-under-Lyme.—Electricity Department. One 150-KW. rotary or motor-converter set and switchgear. See "Official Notices" to-day.

Manchester.—May 28th. Electricity Committee. Stores for 12 months. Mr. F. E. Hughes, Secretary, Electricity Department, Town Hall.

CLOSED.

Barnes.—U.D.C. Tenders accepted:—
Cable.—Henley's Telegraph Works Co., Ltd.
Stoneware ducts.—Doulton & Co., Ltd.

Government Contracts.—List of new contracts placed in April, 1918:—

WAR OFFICE.

X-ray apparatus.—F. R. Butt & Co., Ltd.; Cavendish Electrical Co., Ltd.; H. W. Cox & Co., Ltd.; Medical Supply Association; Schall & Son; Watson & Sons (Electro-Medical) Ltd.
Dynamos.—Electric Construction Co., Ltd.
Electric lighting sets.—Robey & Co., Ltd.
Generating sets.—Austin Motor Co., Ltd.; F. S. Bennett, Ltd.; H. T. Boothroyd, Ltd.; British Westinghouse E. & M. Co., Ltd.; Buffalo Forge Co., Ltd.; H. Green & Co.; J. H. Holmes & Co.; R. A. Lester and Co., Ltd.; Lyon & Wrench, Ltd.; New Pelaphone Engine Co., Ltd.
Motors and parts.—British Westinghouse E. & M. Co., Ltd.; Electric Construction Co., Ltd.; Phœnix Dynamo Manufacturing Co., Ltd.
Switchboards.—Dorman & Smith; J. H. Tucker & Co.
Insulating tape.—B. I. & Helsby Cables Ltd.; India-Rubber & Gutta-Percha Co., Ltd.; Johnson & Phillips, Ltd.; Siemens Bros & Co., Ltd.; A. Terry & Co.
Transformers.—Brush Electrical Engineering Co., Ltd.

INDIA OFFICE, STORES DEPARTMENT.

Cells.—Pritchett & Gold, &c., Co., Ltd.
Generating sets.—Lancashire Dynamo, &c., Co., Ltd.

H.M. OFFICE OF WORKS.

Engineering services, spare parts for conveying plant, grain stores.—H. Simon, Ltd.
National Physical Laboratory.—New aero-dynamics building.
Electric storage battery.—Pritchett & Gold Electric Power Storage Co., Ltd.

POST OFFICE.

Telegraph apparatus.—Automatic Telephone Manufacturing Co., Ltd.; India-Rubber & Gutta-Percha Telegraph Works Co., Ltd.; Telegraph Condenser Co., Ltd.
Telephone apparatus.—Automatic Telephone Manufacturing Co., Ltd.; British L. M. Ericsson Manufacturing Co., Ltd.
Testing apparatus.—India-Rubber & Gutta-Percha Telegraph Works, Co., Limited.
Submarine cable.—Siemens Bros. & Co., Ltd.; Telegraph Construction and Maintenance Co., Ltd.
Telegraph and telephone cable.—B. I. & Helsby Cables, Ltd.; Craigpark Electric Cable Co., Ltd.; Henley's Telegraph Works Co., Ltd.; Johnson and Phillips, Ltd.; Telegraph Construction & Maintenance Co., Ltd.; Union Cable Co., Ltd.; Western Electric Co., Ltd.
Telephone cords.—B. I. & Helsby Cables, Ltd.; Siemens Bros. & Co., Ltd; Western Electric Co., Ltd.
Plug covers.—Spauldings, Ltd.
Insulator spindles and rod stays.—Bullers, Ltd.
Stay swivels.—Guest, Keen & Nettlefolds, Ltd.
Bronze wire.—T. Bolton & Sons, Ltd.; Shropshire Iron Co., Ltd.; F. Smith & Co. (incorporated in the London Electric Wire Co. & Smiths, Limited).
Bronze wire, insulated.—B. I. & Helsby Cables, Ltd.
Annealed copper wire.—Shropshire Iron Co., Ltd.
Copper strand wire.—B. I. & Helsby Cables, Ltd.; Shropshire Iron Co., Ltd.; F. Smith & Co. (incorporated in the London Electric Wire Co. & Smiths, Ltd.)
Galvanized iron wire.—Dorman Long & Co., Ltd.; R. Johnson & Nephew, Ltd.; Rylands Bros. Ltd.; Shropshire Iron Co., Ltd.; F. Smith & Co.; Wire Manufacturers, Ltd.

FORTHCOMING EVENTS.

Royal Society of Arts.—Wednesday, May 29th. At 4.30 p.m. At John Street, Adelphi, W.C. Paper on "Organic Chemistry in Relation to Industry," by Dr. M. O. Forster, F.R.S.

Institution of Electrical Engineers.—Thursday, May 30th. At 6 p.m. At the Institution of Civil Engineers. Annual general meeting.

Junior Institution of Engineers.—Friday, May 31st. At 7.30 p.m. At 39, Victoria Street, S.W. Final informal discussion evening of the session.

(North-Eastern Section.)—Tuesday, May 28th. At 7.15 p.m. At the Mining Institute, Neville Street, Newcastle-on-Tyne. Paper on "Lighting Phenomena," by Mr. S. A. Stigant.

Salford Technical and Engineering Association.—Saturday, June 1st. Visit to Messrs. Matthews & Yates, Ltd., Cyclone Works, Swinton.

NOTES.

Foreign Languages and Trade.—The following letter arrived while we were going to press:—

"Your excellent leader of the 17th inst. establishes the importance of a knowledge of foreign languages in the approaching commercial struggle for overseas trade.

"Should we not, at the same time, appreciate that while there are very many languages of speech there are now substantially only two languages of quantity—viz., our own and the metric system?

"For many years past we have been obliged to employ the metric system to an ever-increasing extent in our export trade, and we thus hamper ourselves by continuing the use of our own obsolete system, because we are thereby employing two languages of quantity when one—the international metric system—would suffice for all purposes.

"In the recently issued report by the Committee on Commercial and Industrial Policy after the War, the statement is made that if we now adopted the metric system we should be required to work in two systems *for a generation*, but, even assuming this were true, it appears to me much less appalling than our alternative prospect of employing two systems *for all time*.

"HARRY ALLCOCK.

"Manchester, *May 21st*, 1918."

Restrictions in the Use of Gas and Electricity.—All communications on the subject of the restrictions in the use of gas and electricity should be addressed to Mr. Graham Roper, C.B., assistant secretary to the Board of Trade, 7, Whitehall Gardens, London, S.W. 1.

Economic Policy.—It is the intention of the Chancellor of the Exchequer to make a general statement shortly on the progress made by the Allies in carrying out the policy agreed to in the Paris Economic Conference resolutions.

The Value of "g" in Engineering and Physical Work.—The effect of variations in the intensity of gravity is very often discussed, but the exact magnitude of the effect and the complete method of taking account of it are never given except in inaccessible treatises. In an article by Dr. Sandford A. Moss in the *General Electric Review* (May, 1918, Vol. XXI, No. 5), the author has collected the data on the matter, and arranged them in convenient shape so that the exact magnitude of the variation is easily seen, and the cases where corrections are necessary are easily found. The data for making the corrections when they are necessary are also worked up in a form which is very much more convenient for actual use than has ever been given before. It is proposed that each laboratory shall work up, once for all, its correction factor for reducing force measurements, &c., to the standard "g" from the data which are given, and thereafter use the factor in experimental work, or not, according to the degree of precision desired. The author, while compiling the article, collaborated with the U.S. Coast and Geodetic Survey officials and with Prof. E. V. Huntington, of Harvard, who is a recognised authority on the subject. The data given may, therefore, be considered authoritative.

For Sale.—Leeds Corporation Tramways Committee invites offers for one 15-ton hand-operated overhead travelling crane. Particulars are given in our advertisement pages to-day.

Volunteer Notes.—London Army Troops Companies, Volunteer Engineers.—Headquarters: Balderton Street, Grosvenor Square, W. 1.

Orders for the week ending June 1st, 1918, by Lieut.-Colonel C. B. Clay, V.D., Commanding.

Captain of the Week.—Capt. E. G. Fleming.

Next for Duty.—Capt. W. Hynam.

Monday, May 27th.—No. 3 Company, 6.30—8.30. Recruits' Drill, 6.30—8.30. Signalling Section, 6.30—8.30.

Tuesday, May 28th.—Lecture on "Demolitions," 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, May 29th.—No. 1 Company, Entrenchments, &c., 6.30—8.30. Recruits' Drill, 6.30.

Thursday, May 30th.—No. 2 Company, Entrenchments, &c., 6—8. Recruits' Drill, 6.30. Signalling Section, 6.30—8.30. Ambulance Section, 6.30—8.30. Band Practice, 7.

Friday, May 31st.—Musketry for the whole Corps, 5.30—8.

Saturday, June 1st.—Knotting, lashing, &c., for the whole Corps, 2.45—4.45. Musketry, 2.45—4.45.

(By order) Macleod Yearsley, *Capt. and Adjutant.*

Fires in Germany.—According to the *Petit Parisien*, there was an epidemic of fires in Germany on Saturday last, including a big outbreak in the works of Siemens-Schuckert in Berlin.

Maintenance of Turbo-Alternators.—Mr. L. Fokes gives some helpful hints and advice on the above subject in the *Colliery Guardian* of April 12th, and particularly with regard to the dismantling of generators for cleaning purposes, he remarks that, in spite of filters, either wet or dry, it is impossible to prevent dust accumulating inside generating plant. It gets there in various ways. Some dust is made by the machine itself—probably from the insulation of the windings. A little gets through the filter, and a much larger quantity is drawn in through the openings for the rotor shaft in the end shields of the generator. The idea that a filter removes all necessity for cleaning generators is quite wrong, and end shields should be regularly removed in order to clean down and varnish the end windings, and also to see if oil or other matter is finding its way into the machine.

Many of the ducts through which the ventilating air has to pass are at right angles to the axis of the machine. It is very difficult to get at these ducts for cleaning, unless a machine is completely dismantled and the rotor removed. This entails a good deal of work, but it ought to be carried out once in three or four years, depending on the conditions noticed when the end shields of the machine are removed.

The removal of the rotor is an operation requiring great care throughout the whole operation, especially in withdrawing it from inside the stator, as the laminated cores of the rotor and stator will not slide one over the other without displacing the core plates and probably driving some into the winding tubes.

When dismantling becomes necessary for cleaning purposes, the generator coupling should be disengaged from the turbine, and the bearing covers removed on either side of the generator. A large sheet of ¼-in. iron should be obtained, about 18 in. or 2 ft. wide, and long enough to project slightly over each end of the rotor. The sheet should be curved exactly to the shape of the inside of the generator stator.

After removing the end shields, the sheet of iron should be introduced between the top of the rotor and the stator, and, while held at each end, should be carefully worked down on one side of the rotor until it lies on the bottom half of the stator and under the rotor. After removing the holding-down bolts of the generator and dismantling the exciter field, a lift should be taken by slings fastened to the stator. As the stator is lifted, the rotor comes to rest on the iron sheet, and the whole is lifted by the crane into a suitable position for removing the rotor.

Having placed the whole machine on suitable packing, the crane should be fastened to one end of the rotor shaft, while a strong trestle is placed under the opposite end, so that a large pole may be used as a lever to ease that end of the rotor upwards as the crane lifts and travels slightly away from the stator, pulling the rotor with it in easy stages.

The iron sheet either travels with the rotor or the latter slides on it, which is immaterial, as in any case the iron readily slides over the surface of either without catching the laminations. When the rotor is half way out, the end of the shaft should be packed up and a final hitch taken round the centre of the rotor by steel slings, under which strips of hard wood, a few inches wide, should be placed to prevent the slings pulling into the air ducts of the rotor and damaging the plates.

While the machine is apart, all air ducts should receive special attention, being thoroughly cleaned by compressed air after all the dust and dirt has been loosened by a brush or other suitable means. It is an advantage after all dirt and dust is removed to spray one thin coat of varnish over the exposed tubes and sides of the slots, as smooth surfaces do not hold the dust nearly so readily as rough surfaces do. Special attention should be given to the bottom half of the stator, as the slots at this point become blocked more quickly than at any other part.

The replacing of the rotor is simply carried out by reversing the operations of removal. The iron sheet is placed in the bottom of the stator before introducing the rotor, and when the machine is in place and the rotor resting in its bearings, the sheet may be removed by working it up to the top of the rotor and withdrawing it. The insertion and withdrawal of the iron sheet at the top part of the machine is necessitated by the bearings, &c., being in the way of introducing or removing it from the bottom.

Referring to slip rings, the author points out that many will have noticed that one of the slip rings on a turbo-alternator wears much more quickly than the other. This wear is often very rapid when the rings are made of soft metal, although it still takes place even when steel rings are used. The current which supplies the excitation of the field is, of course, fed into the rotor by means of one slip ring, while it leaves the rotor by the other ring, and it will be found that the ring conveying the current from the rotor is the one which wears most. There appears to be some chemical action, assisted by the passage of the current from the ring to the brushes, which deposits copper (if the rings are of that metal) upon the brushes, and this in turn may play some part in the rapid wear of the slip rings through the metallic coating impairing the lubricating properties of the contact surfaces. Slip rings are usually difficult to renew, and it is a good plan to change over the leads of the generator field periodically, so that the polarity of the current is changed with reference to the respective rings.

As a result of this practice the rings both wear equally, and their combined life is nearly doubled. The ring surfaces should be kept as true as possible, and any uneven patches should be turned off immediately they appear.

Electricity for Wounded Soldiers.—An electrical apparatus which totally numbs the severest nerve pains, while at the same time gradually bringing about a permanent cure, a machine which will cure acute "water on the knee" in one 20-minute "exposure," and another which charges the patient up like a storage battery, are a few of the wonders of the Radcliffe Infirmary for wounded soldiers at Oxford. The problem of how to exercise electricity on paralysed muscles without unduly stimulating the healthy ones, has been solved by means of a newly-perfected system of condensers, which causes the injured muscles slowly to contract and relax, while the healthy ones remain quiescent.—*Journal of Electricity.*

Fatality.—An inquest has been held into the death of William Lovell, aged 14, a probationary fitter employed by the Avonside Engineering Co., Fishponds, Bristol. He was found dead in a travelling crane at the Avonside works, on a Sunday morning, having apparently been there since the previous afternoon. Dr. Harry Grey, who made a post-mortem examination, attributed death to collapse following congestion of the lungs, and said there was no indication of electric shock. A subsequent examination revealed a mark, which resembled a burn, on the right hand, and although this did not alter Dr. Grey's conclusions, the jury asked for further medical evidence. This was forthcoming when the City Coroner (Mr. A. E. Barker) resumed the inquiry, at the Coroner's Court, on Thursday last week. Dr. Grey added to his previous statement that he did not know on the former occasion that there were live wires which the boy could have touched. He was, however, still of opinion that death was due to congestion of the lungs, and not to electric shock. Dr. E. V. Foss said that the mark on the right hand was evidently a burn, but he could not say how it was inflicted. He was unable to give an opinion as to the cause of death. The appearances noted by observers in cases of electric shock differed, and it was possible that in this case death was due to shock. Dr. J. S. Mather said that it seemed quite possible that the lad received a shock, and the position in which the body was found was that in which he would have expected it to be if there had been contact with the wires. The jury returned a verdict of "Accidentally electrocuted."

Pulverised Fuel.—In a series of articles appearing in the *General Electric Review* under the heading "Methods for More Efficiently Utilising Our Fuel Resources," by Mr. F. P. Coffin, the current issue contains Part XVII, dealing with the extent of the use of pulverised fuel in the industries and its possibilities in the war. The article is presented in two sections; the first section briefly summarises the advantages of pulverised coal, treats of the suitability of its use as fuel for stationary boilers, locomotives, steamships, and metallurgical furnaces, and recommends its adoption to conserve coal resources, and to release for military use the fuel oil now burned for industrial purposes. Following a description of the indispensable part that electric power plays in the preparation, handling, and burning of pulverised fuel, the second section of the article presents an impressive list of the American users of pulverised fuel. The firms mentioned in this list all use American-made equipment.

Foreign Trade.—The April Figures.—The official returns of imports and exports during last month contain the following electrical and machinery figures :—

	April, 1918.	*Inc. or dec.*	*4 months*, 1918. *Inc. or dec.*
Imports.			
Electrical goods ...	64,645	− 41,532	− 207,147
Machinery	754,157	+156,616	+ 907,279
Exports.			
Electrical goods ...	145,244	− 75,161	− 618,020
Machinery	1,308,096	+ 28,331	− 1,914,420

Appointments Vacant.—Station superintendent (£226), for the Rawtenstall Corporation Electricity Department; charge engineer (67s. 6d.), for the Bedford Corporation Electricity Undertaking; two switchboard attendants (58s. 6d.) for the Burnley Corporation Electricity Supply Works; shift engineer (50s.) for the Watford U.D.C. Electricity Department. See our advertisement pages to-day.

Standardisation.—A reader on active service in France, writing to thank us for forwarding copies of the Review, says :—

"I recently received the enclosed verses on standardisation from an engineering friend in Birmingham, to whose battery I used to reply with shot from the Electrical Review locker. I at once thought of you, and obtained permission to pass it on to you. I know you will appreciate it" :—

Standardisation.

Time was when a man, with head and with hand,
Wrought at his trade. Be it breastplate or brand,
Be it crocket or dripstone or saint in his niche,
He put in his best, be it rivet or stitch.
He chose his own iron, he struck his own blow,
He blew his own bellows, and saw his job grow,
And he finished it off with a sigh of content,
For he knew it was good for he knew what he meant.

But now we must all of us do as we're told,
Nor think for ourselves as we used to of old;
'Gainst freedom of growth we've egregiously sinned,
Our outlook is narrow, our knowledge is "tinned."
We've standardised habits and standardised meat,
We've standardised corns on standardised feet;
Each specialised woman and circumscribed man
Has a crystallised brain in a narrow brain-pan!

For the wisdom of genius and the science of sages
Have given us jigs and have given us gauges,
And to make intellectual efforts the fewer,
They've since introduced the professional viewer.
In short, all our means are directed to quench
The heavenly spark by anvil and bench;
Thank goodness, however, we cannot quite dim it,
We've still a few brains that will not pass the "limit"!

April, 1918. A. Y.

A Royal Visit.—On Tuesday the King and Queen, accompanied by Princess Mary, visited various factories in Essex, including a telephone factory, of which Sir John Bethell is chairman of the directors. The Royal party was received with banners bearing messages of welcome and pledges to work loyally till victory is won, and a large number of girls belonging to the night shift lined the way to the workshops; a considerable number of discharged soldiers who are working in the factory were also drawn up, and the King chatted with many of them before entering the works. The processes of turning metal parts, nickel and tin-plating, spray painting, oxy-acetylene welding, and telephone manufacture were in full swing, and the King inspected an exhibit of field telephones and water-tight telephones for use in mines, the purposes of which were explained by the managing director.

The I.E.E. Wiring Rules.—The Council has adopted a recommendation of the Wiring Rules Committee that Rules No. 68 and 69 in the 7th edition of the Wiring Rules (issued March, 1916) be cancelled and that the following be substituted :—

New Rule 68*X*.—Unarmoured conductors having a sheathing containing not less than 95 per cent. pure lead (the remainder consisting of rarer metals) and of a thickness not less than that specified in the Engineering Standards Committee's Report (No. 7) on "British Standard Copper Conductors" may be used provided that—

(*a*) They are supported by means of clips, saddles, or clamps of such form as will not indent or damage the sheathing and, if metallic, of some metal other than copper. The supports shall be at intervals sufficiently short to prevent appreciable sagging of the conductor.

Conductors when vertical shall be fixed by the same means, with supports at the same intervals, as when horizontal, unless they be inaccessible, when a length not exceeding 10 ft. may be allowed between the supports provided that the upper support firmly grips the cable or wire, and that where there is a change of direction from horizontal to vertical they are brought over a rounded support of a radius not less than three times the external diameter of the sheathing.

(*b*) They are protected by wood or metal casing or conduit where exposed to mechanical injury, and by metal conduit (Rule 63*a*) where buried in plaster, cement, or brickwork. Such conductors laid between floors and ceilings, between lath and plaster or other hollow partitions, or through partitions and walls, need not be so protected.

(*c*) They do not come into contact with damp brickwork or plaster.

(*d*) The metal sheathing of the conductors is earthed and is made electrically continuous throughout by means of wiped joints, or alternatively, by bonding clamps specially designed for the purpose or forming part of boxes or similar fittings entered by the conductors. The continuity of the sheathing shall comply with Rule 69*X* and the earthing with Rules 34 and 35.

New Rule 69*X*.—The resistance of the metal sheathing between any two points of a completed installation shall not exceed two ohms.

Cheese-Making in a Power House.—Canon Sutton, chairman of the Cumberland County Council, has been instrumental in starting a cheese factory at Bridekirk, Cockermouth, which the Board of Agriculture have equipped with plant capable of dealing with 200 gallons of milk daily. The factory has been established in an electric power house belonging to Colonel Green-Thompson.—*Times*.

Metropolitan Munitions.—According to the *Times*, it has been arranged by mutual agreement that the work hitherto done in the London district by the Metropolitan Munitions Committee shall be transferred to the Ministry of Munitions as from July 1st. A letter has been received by the Committee expressing the Minister's cordial appreciation of the very valuable work that has been done.

Electrical Power Engineers' Association.—A general meeting of the Northern Division of the Association was held on May 16th at Manchester, and, in spite of the summer-like weather, there was a good attendance of members and visitors. In the opening remarks of the chairman (Mr. A. L. Lunn) attention was drawn to the steady growth of the membership of the Division, especially in Scotland, the 400 mark having been passed already. During the meeting the findings of the Arbitrator in the Brighton test case were commented upon, the result being considered highly satisfactory, and fully demonstrative of the need for an Association such as the E.P.E.A.

A discussion took place on the prospective Association outlined by Mr. C. H. Wordingham (President I.E.E.) in his address to the Manchester Section of the I.E.E. on April 23rd. There was a general feeling that such a new Association was not required, as the E.P.E.A. was already carrying out the idea put forward by Mr. Wordingham.

The chairman announced the formation of a Sub-Committee to draw up a syllabus for the winter session, and to make the necessary arrangements for papers, &c.

The names of four delegates to represent the Northern Division at the meeting of the National Executive Council, to be held at Birmingham during Whit week, were submitted to the meeting and approved.

The next general meeting of the Northern Division will be held at the Grosvenor Hotel, Manchester, on Thursday, June 20th.

Protecting Castings Against Rust.—According to the *Zeitschrift des Vereines Deutscher Ingenieure*, M. Stübing, an Austrian engineer, puts forward an electrolytic process by which castings may be quickly coated with a layer of cadmium and copper, or cadmium and zinc, as a protection against rust. The protecting layer has a silvery appearance, and can be used for the protection of both iron and steel. The electrolyte is formed by dissolving in 100 litres of water, 1 kgm. of cadmium hydroxide (in the form of sulphate or nitrate), and 1 kgm. of copper hydroxide (in the form of carbonate, acetate, nitrate, or sulphate), mixed with cyanide of potassium or sodium. The object to be plated is first cleaned with dilute acid and then used as the negative electrode, the positive electrode being a plate of copper or zinc. The pressure used is 4 volts, at a current density of 30 amps. per sq. metre of surface to be plated.—*Génie Civil*.

Trading with the Enemy Committee.—The report of this Committee, which has completed its labours, has been laid on the table of the House of Commons. We hope to refer to the matter in a later issue.

Exhibition of Women's Work.—The Labour Supply Department of the Ministry of Munitions of War is holding an Exhibition of photographs and specimens of women's work on munitions of war and allied industries at the Whitechapel Art Gallery. The Exhibition was opened on Wednesday afternoon. It will be open to the public daily on week-days from 12 noon to 9 p.m., and on Sundays from 1 p.m. to 6 p.m., until Thursday, June 20th. The purpose of the Exhibition is to illustrate the progress that has been made in the introduction of women and other hitherto untrained labour, in order to set free skilled or semi-skilled men for the purpose of up-grading or expanding the available supply. From what we have ourselves seen at previous exhibitions of the kind, we think it highly desirable that firms in the London district should arrange for their staffs, and many of their employés, to attend and inspect the exhibits now on view.

"Safety First" in Industrial Work.—The Lord Mayor will preside at a meeting at the Mansion House, on June 12th, at 4 p.m., to inaugurate an extension of the "Safety First" campaign to industrial work.

Why Brown Transgressed.—When Thomas Brown, a baker, of Fulham Road, was summoned at the West London Police Court for selling bread which had been baked less than 12 hours previously, his solicitor explained that baking was delayed for three hours in consequence of an electric wire fusing. He was fined £20.

Institution and Lecture Notes.—Institution of Electrical Engineers.—The annual meeting of the NEWCASTLE-UPON-TYNE LOCAL SECTION was held on May 13th, Mr. A. H. Marshall in the chair. The report of the Committee stated that the total membership had slightly increased—from 250 last year to 258. The session had been noteworthy for the fact that three papers by local members had been given before the Institution in London and other centres. A most successful reception and meeting were held on the occasion of the President's visit, and, as the result of a suggestion made by Mr. Wordingham, in the course of his address, representations had been made to the Council by the local Committee with a view to the Local Section taking, in the immediate future, a more active part in research and other matters at present engaging the attention of the Council. This Committee had under consideration at present, in collaboration with other local institutions, the formation of an 'engineers' club in Newcastle, on somewhat similar lines to that already existing at Manchester. It was hoped that an announcement on the matter would be made at an early date. It was again deemed undesirable to hold a dinner, and many members, instead, gave loyal support to the electrical training of disabled sailors and soldiers at the Cowen Home in Newcastle, the sum of £17 16s. 6d. having been thus contributed. A large number of Local Section members were still engaged in His Majesty's Forces; one of the members, Capt. (Acting Major) G. S. Taylor, was awarded the Military Cross, and several members also had been promoted; unfortunately, they had to record the loss of Capt. C. R. M. Young, who died of wounds received in France. The past-chairman, Mr. H. W. Clothier, had been nominated by the Council for election thereto.

The officers and Committee for the session 1918-19 were as follows:—Chairman, Mr. A. P. Pyne; vice-chairmen, Mr. W. Cross and Mr. J. R. Andrews; past-chairmen, Messrs. A. H. Marshall, H. W. Clothier, and P. V. Hunter. Committee:—Power Supply Undertaking—Messrs. E. Fawssett, J. W. Jackson, R. M. Longman, G. L. Porter. Manufacturers and Contractors—L. H. A. Carr, A. Collins, V. O. I. Davis, J. H. Holmes, A. H. Law. Universities and Technical Colleges—Messrs. F. O. Hunt, W. T. MacCall, Dr. W. M. Thornton. Borough Electrical Engineers—H. S. Ellis. Consulting Engineers—Messrs. R. W. Gregory, W. C. Mountain. Civil Service and Railways—Messrs. F. G. C. Baldwin, C. E. Taylor, and the chairman, Tees-side Section, Mr. H. G. A. Stedman; *ex-officio*, hon. treasurer, Mr. C. Vernier; hon. secretary, Mr. J. R. Andrews; assistant hon. secretary, Mr. J. R. Beard; Tees-side assistant hon. secretary, Mr. P. S. Thompson; hon. auditors, Messrs. C. Turnbull and W. F. T. Pinkney.

Mr. C. Vernier, the hon. treasurer, submitted the annual financial statement, which showed a credit balance of £49, and the reports were adopted.

The chairman referred to the sad loss Sir Charles Parsons had sustained by the death in France of his son, Major Parsons. A vote of sympathy was passed in silence, members standing.

Institution of Gas Engineers.—The annual meeting is to take place on June 4th and 5th, at the Institution of Civil Engineers, Westminster, under the presidency of the Right Hon. Lord Moulton, G.B.E.

The Institution of Electrical Engineers. — ANNUAL REPORT AND ACCOUNTS.—The report of the Council for the year 1917-18, to be presented at the annual general meeting on May 30th, states that the membership shows a net increase of 54, being now 6,667; in addition, 55 candidates for Associate Membership have been approved by the Council for admission, subject to their satisfying the examination regulations. The total number of alien enemies whose membership has ceased is 42. A rule has been adopted providing for the admission of shift engineers as Associate Members, after holding full responsibility for two years for the plant and staff in a station where 12 men or more are employed, or for a section of a station having not less than 2,000 KW. of load, besides satisfying the regulations as regards training and education as an electrical engineer. An Employment Register is to be set up to assist members serving in H.M. Forces, or engaged on war work, to find suitable employment when demobilisation takes place. Thirty members have given their lives in the service of their country during the year.

The total number of Committee meetings and conferences held during the year amounted to 112.

The Panels set up by the Council to organise researches in connection with insulating materials have made considerable progress; the British Electrical and Allied Manufacturers' Association is co-operating with the Institution, and the Department of Scientific and Industrial Research has made a grant of £2,050 to the Electrical Research Committee (consisting of three members nominated by the I.E.E. and three by the B.E.A.M.A.), which it appointed in May last year. The research on buried cables is proceeding, and involved an expenditure of £324 in 1917, of which £296 was contributed by electricity supply undertakings; the Research Department has provided £750 towards the cost of a special machine at the National Physical Laboratory for the purpose of the tests. The research on insulating oils cost £467 in 1917, of which the Research Department paid £421.

The number of members serving with the Forces since the outbreak of war is 1,869.

The training of disabled men at the Northampton Polytechnic Institute was taken over by the War Pensions Statutory Committee in June, 1917. Up to the end of March last, 17 courses had been carried out; 285 men had entered the courses, and 245 were placed. The number of applications received from employers was over 450.

The Council is taking an active interest in the proceedings of the Engineering Training Organisation, and is contributing £100 to its expenses for the current year; the I.E.E. is represented on the Organisation by Mr. C. H. Wordingham, who has been elected vice-chairman of the Executive Committee.

The Council has appointed a Committee to prepare a scheme for the formation of an Electrical Cooking and Heating Association.

The capital account of the Benevolent Fund at the end of 1917 stood at £4,642, and the accumulated income at £2,062. Donations and subscriptions to the Fund in 1917 amounted to £194, and 14 grants were made, absorbing £198.

The annual accounts of the Institution show an excess of income over expenditure, after providing £3,000 for mortgage redemption and contingencies, of £2,090, compared with £3,777 in 1916. The mortgages now stand at £31,914. The assets amount to £127,897 and the liabilities to £43,117, leaving a balance to the good of £84,780, an increase of £6,591.

During the year 354 books were issued from the lending library to 191 borrowers, comparing with 516 and 240 in 1916.

Munition Workers' Health.—The Minister of Munitions has appointed a Committee "to advise him upon the general principles to be adopted in carrying out the welfare and health work of the Ministry, and to report to the Minister on all matters connected with the same which may be referred to them by him from time to time." The chairman of the Committee is Mrs. H. J. Tennant. The secretary to the Committee is Mr. R. H. Crooke, 53, Parliament Street, S.W. 1, to whom all communications on the subject should be addressed.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*

Central Station Officials.—MR. F. WOODS, station superintendent, Rawtenstall Corporation, has been appointed resident engineer to the Woking Electric Supply Co.

MR. A. BAXENDALE, of Bolton, has been appointed car-shed superintendent of the Rawtenstall Corporation tramways.

The Grimsby Electricity Committee recommends that MR. A. C. CHANNON be granted an increase of £50 per annum in his salary.

Stepney B.C. Electricity Committee recommends that, in consideration of the extra work and responsibility which devolved upon MR. W. YOUNG, the resident electrical engineer, and MR. A. J. SQUIRE, the deputy commercial manager, consequent upon Mr. Tapper assisting the Coal Controller, the Council do make a payment of £50 to Mr. Young and Mr. Squire respectively out of £535 received from the Treasury on account of Mr. Tapper's services, and standing to the credit of the electricity account.

Last Saturday Mr. H. BAKER, confidential clerk to the acting city electrical engineer at Hull, was presented with a gold watch, on the occasion of his leaving to take up an appointment with the Rotherham Electricity Department. Mr. Coverdale, the chief clerk, made the presentation.

General.—Another of the heads of departments at the Massachusetts Institution of Technology has been requisitioned by the U.S. Government, PROF. DUGALD C. JACKSON, in charge of the Department of Electrical Engineering. Prof. Jackson was virtually approved for a commission by the Chief of Engineers before war was declared. In December last Prof. Jackson took the formal oath, and has now been ordered "over there." His commission is that of major in the Engineer Reserve Corps. During his absence Dr. A. E. Kennelly, A.M., S.D., Professor of Electrical Engineering, will be acting head of the department at the M.I.T.

MR. W. G. WICKHAM, H.M. Trade Commissioner in South Africa, is now in this country.

The *Times* states that Sir Gilbert Parker, M.P., having decided not to seek re-election for Gravesend, MR. ALEXANDER RICHARDSON, the editor of *Engineering*, has been adopted prospective candidate at a meeting of the Conservative and Unionist Executive.

Roll of Honour.—PRIVATE J. ROSE, West Yorkshire Regiment, who is wounded, was with the Phœnix Dynamo Co., Ltd., Bradford.

PRIVATE J. H. BAXTER, R.E., who has died of wounds, was a cable jointer at the Halifax Post Office.

SERGEANT-MAJOR STANLEY PARKER, K.O.Y.L.I., missing, was an electrician at the Ackton Hall Colliery.

PRIVATE J. MORLEY, Loyal North Lancs. Regiment, killed, was with Messrs. Chas. Macintosh & Co., Ltd., Manchester.

CORPORAL C. ANDERTON, R.E., who is in hospital at Perth, has been awarded the Military Medal for gallantry in the field. He was formerly engaged at the Formby power house of the Lancashire and Yorkshire Railway, and joined the Army as an electrician.

PRIVATE J. RAYNER, Loyal North Lancashire Regiment, who has died of wounds abroad, was employed at the United Electric Car Works, Preston.

CORPORAL G. F. LANGSTON, R.E., who has died whilst on service, was formerly employed by Mr. Albert Sudlow, electrical engineer, Manchester.

CORPORAL E. LESLIE, South Lancs. Regiment, who has been killed at the Front by an explosion on a railway, was employed in the Warrington Corporation electricity department.

Private O. G. Billingham, Manchester Regt., who enlisted from the Northampton E.L. works, is reported missing.

The death has occurred from wounds of Sapper J. Hammond, formerly on the staff of the electricity department of the Malvern Urban District Council.

Capt. H. E. Turner, mains superintendent under the Hull Corporation electricity department, has been killed in action. Recently he was decorated by the King of the Belgians as a Chevalier of the Ordre de la Couronne. He had also received the Croix de Guerre.

Private Glyn Griffiths, formerly engineer at the Pontypridd electricity works, has been killed in action.

Corporal J. Hamilton, formerly employed in the telephone department of the Newcastle General Post Office, has been awarded the Military Medal for great gallantry and devotion to duty.

Lieut. J. B. Langley, R.A.F., son-in-law of Sir Oliver Lodge, was recently killed while flying in this country, aged 29.

Obituary.—Mr. Charles S. Garnett, manager of the Darwen Corporation electricity works, whose death in his 41st year was mentioned last week, was appointed manager of the works in 1901, when only 23 years of age, in succession to Mr. Stanley Clegg, to whom he had previously been assistant. The interment was of a public character, being attended by the Mayor and Corporation. The procession was led by a body of special constables, of which Force the deceased was a member.

The death occurred at St. Bartholomew's Hospital, on May 9th, of Mr. Wm. Hughes, traffic superintendent with the South Metropolitan Tramways Co.

Mr. Gilbert Tweedie, accountant of the County of London Electric Supply Co., Ltd., recently died suddenly in his office, at the age of 51 years. An inquest was held. A verdict was returned, in accordance with medical evidence to the effect that hæmorrhage on the brain, following recent and old-standing meningitis, was the cause of death.

REVIEWS.

Theory and Calculations of Electrical Apparatus. By Dr. Charles Proteus Steinmetz. London: Hill Publishing Co. Pp. 480 + xxii. Price 17s. net.

In his preface, Dr. Steinmetz alludes to the great developments which have taken place in the theory of electrical engineering since the first publication of his "Alternating-current Phenomena" 20 years ago. In successive editions this original work, which has long ranked as a classic in the literature of electrical engineering theory, has had to be expanded, until at last it has overflowed the limits of a single volume. Accordingly, "Alternating-current Phenomena" has now been separated into three parts under the respective titles of "Alternating-current Phenomena," "Electric Circuits," and "Electrical Apparatus"—the last-named being the volume before us.

For students of Dr. Steinmetz's earlier works, no further recommendation will be necessary than the bare statement that the present volume is fully typical of its author's previous work in its plain and lucid treatment, its simple vectorial analysis, its copious illustration by characteristic curves of performance, and in its masterly reduction of apparently complicated and involved relationships to simple diagrammatic or algebraic expressions—the whole being expressed in simple and unambiguous terms, often with a certain quaintness of expression which one has grown to associate with the name of Steinmetz.

Possibly one word of explanation should be given in regard to the title of the book, which is not well calculated to give a correct impression of the subject matter of the contents. Speaking broadly, the book deals mainly with such types of alternating-current machinery as have as yet found little or no commercial application, and with the adaptation of commercial types to exceptional conditions of operation. In short, a good deal of the discussion is concerned with what are at present regarded as "freaks," but "freaks" of the kind which may, in times to come, be called upon to meet some new demand of the future which cannot as yet be foreseen. The engineer is often called upon to face new problems, or to solve old problems by new methods made necessary by new industrial conditions. In so far as questions of this kind are concerned with alternating-current motors or converters, probably no more stimulating or suggestive aid could be found by the earnest searcher than this latest volume of Steinmetz. The designer or electrical engineer who is often apt to get somewhat restricted in his outlook and experience by a constant repetition of routine calculation based on certain standardised assumptions, will find it refreshing to read about many types of machines which lie outside the normal standards of his everyday practice, such as multi-speed induction motors, motors with multiple squirrel-cages, hysteresis motors, reaction and inductor machines, unipolar generators, and other devices which might otherwise never occur to him as subjects affording scope for profitable and interesting study, even if not of immediate practical use in his work.

The commutating pole, or interpole, was a device which had been known and discussed in its theoretical aspects for many years before its use was recognised as being of industrial importance. It was only when higher speeds and higher armature reactions became common that this "freak" device was found to be valuable, and ultimately came into general use in nearly all large direct-current machines and synchronous converters, and thus ceased to be a "freak" any longer. Another example of an apparently useless theoretical development, which later became of great industrial importance, is the alternating-current commutator motor. Thus, it is evident that for a progressive engineer, it is dangerous not to be familiar with the characteristics and possibilities of the known, but unused, types of apparatus, since it is impossible to foresee when circumstances may arise which will lead to their extensive introduction.

It must, however, not be thought that this volume includes no discussion of machines which are of industrial importance at the present time. This is far from being the case. The full treatment accorded to the various types of single-phase commutator motors is most illuminating, while such subjects as the design of induction motors for special speed characteristics, rectifiers, regulating pole converters, &c., would prove of very real value to the engineer who is called upon to deal with such matters.

In the first chapter, the speed control of induction motors is considered. The problem of securing a high torque over a wide range of speed leads to the successive discussion of a temperature starting device, comprising a rotor winding of high temperature coefficient, a hysteresis starting device, and an eddy-current starting device. Constant speed operation is dealt with in connection with pyro-electric conductors employed for the rotor winding, the use of a condenser in the secondary circuit, and the construction of a "multi-speed" motor with variable number of poles.

The second chapter is devoted to the theory of induction motors provided with multiple squirrel cages, *i.e.*, with two or more separate rotor windings having respectively high and low resistances. The torque of the motor is the sum of the torques due to the several rotor windings; thus the high-resistance winding is responsible for the greater part of the torque at low speeds, and the winding of low resistance is the more effective at speeds near synchronism. We notice in this connection that no reference is made to the proposal to allow a special high-resistance squirrel cage to run free in the air-gap, instead of embedding it with the other winding in the slots of the rotor—a device which has been suggested for reducing the starting current with heavy loads, and is especially applicable to single-phase induction motors.

In the next chapter the cascade, or tandem, connection of induction motors is treated of, while this is followed by a chapter dealing with devices by which the rotor of the motor receives the excitation, instead of the stator. These devices include a motor concatenated with a synchronous alternating-current machine, and with a commutating machine (as in the Lacour motor converter), and finally the Heyland type of compensated motor.

Then follows a chapter on the single-phase induction motor, with the consideration of the numerous alternative starting devices. Further chapters deal with the regulation and stability of induction motors, higher harmonics in induction motors (an interesting analysis of the harmonics due to various spacings of the winding, and the torque due to them), synchronising induction motors, and the synchronous induction motor.

A chapter on the hysteresis motor suggests certain interesting problems which arise when iron is subjected to the influence of a rotary magnetic field.

The frequency converter, or "general alternating-current transformer" forms the subject of an interesting and characteristic chapter in which the stator and rotor circuits of the induction motor are treated from a general point of view as the primary and secondary of a power transformer, in which the transformed power appears partly in mechanical and partly in electrical form. The motor converter supplies an apt illustration of the value of this aspect.

Synchronous induction generators, in which the excitation is supplied to the secondary at a constant low frequency, are the next type of machine to receive consideration, and there follows next a chapter on phase-conversion, which, of course, includes the well-known induction regulator and balancer. Synchronous rectifiers are fully discussed, but electrolytic or arc rectifiers are not included.

Next, we have chapters on reaction machines (*i.e.*, machines which operate in virtue of variations in the reaction flux produced in different positions of the rotating element), inductor machines, and, later on, unipolar machines.

The chapter on single-phase commutator motors has been alluded to already, and forms a clear and masterly survey of this class of machines. Perhaps no type of electrical problem lends itself so well to a general treatment by Steinmetz's methods of analysis, and presents more difficulties to other methods of approach. Whether this is true or not, this chapter is well worth the most careful study, if a clear general view of the characteristics of the various forms of alternating-current commutator motor is sought.

Finally, the chapter on the regulating pole converter contains many interesting points connected with the design and characteristics of the rotary converter, and is valuable from a more general point of view than its title suggests.

Perhaps the reviewer may conclude with a statement of fact and a word of advice. Some electrical engineers read Steinmetz, whereas some don't. If you do, you should certainly

get hold of this volume and study it; if you don't, you should begin to do so, but preferably with one of the earlier volumes of this valuable series.

Theory and Operation of Direct-Current Machinery. By C. M. JANSKY, B.S., B.A. London: Hill Publishing Co., Ltd. Pp. 285 + x, 214 figs. Price 10s. 6d. net.

This book deals solely with the construction and operation of direct-current machines, and with the subsidiary appliances connected therewith, and is intended for the use of men who have little knowledge of mathematics. The matter is divided into 16 chapters, each being provided with a useful summary recapitulating the main points. Five chapters are devoted to main principles, including studies of magnetism, units, laws governing the flow of currents in electrical circuits, and the transformation of energy, in each case little preliminary knowledge being assumed. In dealing with the flow of currents in circuits, more than usual prominence is given to Kirchhoff's laws; this is to be commended, since they are of great use in connection with the study of any problems concerning networks of conductors. The problem of resistances in parallel is not perhaps dealt with in the simplest way, a complicated type of formula being commonly employed. In one problem concerning work English readers may be startled by the fact that a gallon of water is taken as weighing 8.35 lb., and the point certainly adds weight to the agitation for a more uniform system of units.

Some nine chapters are devoted directly to the study of dynamos and motors, and these may be particularly commended from the operating standpoint. Characteristic curves, both of dynamos and motors, are also well explained.

A couple of chapters are set aside for the consideration of systems of distribution, particular attention being paid to three-wire systems. The treatment is generally very clear, but in several places evidence of haste is given, thus the number of dynes in the pound is given as 444,800 on page 43, and as 445,000 on page 62, the latter number being more nearly correct. Again, on page 220, in dealing with the rheostatic control of a series motor, the author states that the only efficient speed is half-speed. We are at a loss to understand this statement, unless the writer has in mind a series parallel control (which is not suggested in the paragraph, and which, as a matter of fact, is dealt with later).

The diagrams, both line and half-tone, are well reproduced, and in the main are of a most suitable kind, though we suggest that a half-tone block of a standard kilogram under two glass jars is not really helpful to the reader of a book of this nature. In fig. 145, showing a diagram of a Tirrill automatic regulator, there is an error in the drawing of the coils of one of the electromagnets. The action of the magnet is correctly indicated in the text, but as drawn it would quite fail to operate. The printing and general arrangement are excellent, and the book is very suitable for men engaged in the operation and construction of direct-current machines, particularly if they are so situated as to be unable to attend any classes, and their need is a book containing the necessary explanations reduced to the simplest form.

NEW COMPANIES REGISTERED.

Cooling Equipment, Ltd. (150,441).—Private company. Registered May 15th. Capital, £1,000 in £1 shares. To acquire an invention relating to fluid cooling devices, and to carry on the business of mechanical and electrical engineers, &c. The subscribers (each with one share) are:—T. H. Wilson, Pinners Hall, E.C. 2, merchant; A. T. Lack, 106, Darwin Street, S.E. 17, clerk. The first directors are to be appointed by the subscribers. Solicitors: Francis & Johnson, 19, Great Winchester Street, E.C.

Electro Leather Industries, Ltd. (150,443).—Registered May 15th. Capital, £100,000 in £1 shares. To take over the business of a tanner, hide steriliser, electrical and chemical specialist, and manufacturer carried on by L. A. Groth at Grothine Works, Coulsdon, Surrey, as the Electro Leather Industries. Minimum cash subscription, £70. The first directors are:—L. A. Groth, Grothine Works, Coulsdon, Surrey; A. B. Swales, 9, Scrubbs Lane, N.W.; I. Smith, 42, Heath Crescent, Halifax; G. L. Shepherd, Clare Valley, The Park, Nottingham; A. Jessop, Woodeliff, Rawden, Leeds. Solicitor: J. J. Spence, 13, Park Row, Nottingham.

Crypto Electrical Co., Ltd. (150,466).—Private company. Registered May 17th. Capital, £50,000 in £1 shares (10,000 pref.). To take over the business of electrical engineers, formerly carried on by J. G. Shaw and C. R. Shaw as the Crypto Electrical Co. at Acton Lane, Willesden, and elsewhere. The subscribers (each with one share) are:—J. G. Shaw, Crypto Works, Acton Lane, Willesden, electrical engineer; C. R. Shaw, Crypto Works, Acton Lane, Willesden, electrical engineer. The first directors are:—J. G. Shaw and C. R. Shaw, each of whom may retain office while holding 10,000 shares of either class. Registered office: Crypto Works, Acton Lane, Willesden.

Sentinel Wagon Works, Ltd. (150,470).—Registered May 17th. Capital, £125,000 in £1 shares. To take over as at December 31st, 1917, that portion of the business of Alley & MacLellan, Ltd., engineers and shipbuilders, of Polmadie, Glasgow, which is carried on by them for the manufacture of steam motor wagons at Shrewsbury; also to carry on the business of motor, marine, electrical, and general engineers, iron and brass founders, airship and aeroplane manufacturers, &c. The subscribers (each with one share) are:—S. E. Alley, Sentinel Works, Shrewsbury, engineer; K. M. Alley, Sentinel Works, Shrewsbury, engineer; T. A. Paul, Dunarden, Helensburgh, retired merchant; D. W. McMillan, 143, Bolshagray Avenue, Glasgow, secretary; J. D. Campbell, 95, West George Street, Glasgow, solicitor; K. A. Borland, 95, West George Street, Glasgow, solicitor; A. Brown, 95, West George Street, Glasgow, solicitor. The first directors are:—S. E. Alley, K. M. Alley and T. A. Paul, with power to add four others to their number. S. E. Alley is managing director, and may retain office while holding 20,000 shares. Registered office: Shrewsbury, Salop.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Bastian Meter Co., Ltd.—Memorandum of satisfaction in full on September 1st, 1917, of trust deed dated August 21st, 1905, securing £6,000, has been filed.

English Electrical Co., Ltd. (112,639).—Capital, £5,000 in £1 shares. Return dated March 1st, 1918. 326 shares taken up; £326 paid. Mortgages and charges: £10,000.

Cross & Cross, Ltd. (105,754).—Capital, £5,000 in £1 shares. Return dated January 31st, 1918. All shares taken up; £4,845 paid; £155 considered as paid. Mortgages and charges: £600.

Folkestone Electricity Supply Co., Ltd. (51,825).—Capital, £100,000 in £5 shares. Return dated April 26th, 1918. All shares taken up; £100,000 paid. Mortgages and charges: £94,150.

City of London Electric Lighting Co., Ltd. (34,406).—Capital, £1,200,000 in 80,000 ord. and 40,000 pref. shares of £10 each. Return dated April 3rd, 1918. 70,595 ord. and 40,000 pref. shares taken up; £1,105,950 paid. Mortgages and charges: £800,000.

CITY NOTES.

West London and Provincial Electric Supply Co., Ltd.

Mr. H. KAHN presided at the annual meeting on May 15th. He said that they had received £628 more from their holding in the Chiswick Co. owing to their having increased their dividend by 1 per cent. to 6 per cent. for 1917. The management fees received from the Chiswick Co. increased by £575, and the net result was a balance of profit of £3,495. They proposed a dividend on the cumulative preference shares of 6 per cent., less tax, and the interest in arrears for the year 1912 of 4½ per cent. on the funding certificates, leaving £61 to carry forward. The Chiswick Co. (which also supplied at Aberystwyth) showed an increase of £10,360 in sale of current, due in a great measure to the enhanced supply of power for certain works. Cost of generation was £3,290 higher than last year, owing to higher coal, stores, and wages costs. The arrangement with the Hammersmith Council for supply in bulk had worked satisfactorily, and they purchased from the Council current costing £3,924. The Chiswick Co. raised its prices for current in Chiswick by another 10 per cent. at the beginning of the December quarter, making 30 per cent. in all. In Aberystwyth nothing further could be done as the maximum price was already being charged there. It was very difficult to make predictions for 1918 because there was no knowing how much further fuel and oil might go up in price. There was also the 12½ per cent. addition to wages and salaries, the lengthened daylight saving period, &c. Mr. W. B. Esson, the managing director, seconded the adoption of the report.

Austrian Companies.

The accounts of the *Elektrizitats A. G. vorm. Kolben & Co., of Prague*, show net profits and balance forward of £78,000 for 1917, as compared with £72,000 in the preceding year. It has been decided to distribute 10 per cent., this rate contrasting with 9½ per cent. in 1916.

The Ganzsche Elektrizitats A.G., of Buda Pesth, intends to distribute out of net profits of £65,000 a dividend at the rate of 8 per cent. for 1917, as in the preceding year. A year ago it was decided to raise the share capital from £500,000 to £760,000.

The A.G. fur Elektrische Unternehmungen Phœbus, of Buda Pesth, which incurred a loss of £49,000 in 1915, and a lesser loss in 1916, reports insignificant profits for last year, which are carried forward. The company, which has paid no dividend since 1913, now proposes to augment its share capital from £55,000 to £208,000.

The financial statement of the *Felten & Guilleaume A.G., of Buda Pesth*, exhibits net profits of £42,000 for 1917, as compared with £32,000 in the previous 12 months, the sum of £7,000 and £11,000 having been written off for depreciation in the two years respectively. The directors recommend a dividend of 15 per cent., as in 1916, although the share capital participating is larger.

The Carborundum und Elektrit Werke A.G., of Vienna, which also owns works at Dusseldorf (Germany) and at La Bathie (France), reports an increase in the gross profits in 1916-17. After allocating £11,000 to depreciation, as against £4,700 in 1915-16, the accounts show net profits of £27,000, as contrasted with £17,000. The directors recommend the payment of 17 per cent. as compared with 11 per cent., 5 per cent., and 12 per cent. in the three preceding years respectively.

The Felten & Guilleaume A.G., of Vienna, after applying £33,000 to depreciation in 1917, as against £36,000 in 1916, reports net profits of £172,000, as contrasted with £153,000 in the previous year. It is proposed to pay a dividend of 20 per cent., being the same rate as in 1916. The directors state that all departments are well supplied with orders for the current financial year, and full activity would be assured if difficulties did not exist in the matter of procuring coal and other raw materials. The share capital is now to be increased from £354,000 to £416,000 by the issue of new shares at the price of 800 per cent.

Calcutta Electric Supply Corporation, Ltd.—The report for 1917 shows as follows:—Units sold 26,596,827, against 23,575,211 in 1916. Houses connected 9,741, an increase of 280. Gross revenue £259,397, against £237,353. Net revenue £173,949, against £167,370. Exchange 1s. 4d. per rupee. The net profit for 1917, plus the balance brought forward, and interest received, totals £241,070. £39,552 has been placed to the credit of the depreciation and renewal account. Excess profits duty for 1915 and 1916 and an estimated £15,000 for 1917 are provided for, £2,500 is put to reserve, £4,000 to insurance fund, and the total dividend on the ordinary shares is 10 per cent. for the year, leaving £45,964 to be carried forward, after providing for the directors' additional remuneration of £3,000. A pension fund for the staff is to be established, and £7,500 has been placed to the debit of net revenue as a nucleus thereof. Expenditure on capital account last year £23,910. The demand for electrical energy continues to increase.

Potteries Electric Traction Co., Ltd.—Revenue for 1917, £176,745. Traffic and parcel receipts increased by £24,972. Expenses increased by £24,972, although many repairs and practically all renewals have had to be deferred. After paying expenses and debenture interest, and putting £10,000 to renewals, £12,500 is put to reserve, 5 per cent. preference dividend is paid, and 3½ per cent. on the ordinary, carrying forward £8,380. War wages and bonuses were twice increased during the year, and since the close a further increase has been awarded, making the total amount paid in war wages or bonus to male employés 20s. per week, and to female employés 13s. per week over pre-war rates. The right of the Stoke-on-Trent Corporation to purchase the tramways does not arise again until 1924 and 1932. Fares are to be raised to enable suitable reserves to be accumulated, and to meet the increased cost of working.

Electric Construction Co., Ltd.—The net profit for the year ended March 31st, 1918, after providing £6,559 for debenture interest and £10,000 for depreciation, is £66,826, plus £31,442 brought forward, less excess profits duties paid for two years ended March, 1917, £30,240. After paying 7 per cent. on the preference shares for the year, and a final dividend at the rate of 9 per cent. per annum on the ordinary, making 7½ per cent. for the year, and a bonus of 2½ per cent. on the ordinary, all under deduction of income-tax, £9,326 is to be transferred to general reserve, leaving £31,887 to carry forward, subject to liability to excess profits duty. The report states that operations were conducted during the year under abnormal conditions, but, notwithstanding, a large measure of success has been achieved, which is indicated by a substantial increase both in turnover and in net profit. Meeting: May 29th.

Indian Electric Supply & Traction Co., Ltd.—The surplus on working for 1917 in Cawnpore was £17,767, against £20,220 in 1916. Total at credit of net revenue £18,189, and after providing for London expenditure and debenture interest the profit is £12,073, plus £1,757 brought forward. £6,000 is put to reserve for depreciation and renewals, £1,000 to debenture issue expenses, and after paying 7½ per cent. dividend on the shares, and £293 directors' commission on dividends, £685 is carried forward. Mr. W. H. Cheetham has retired from the board, and Sir R. P. Ashton has been appointed in his place.

West India & Panama Telegraph Co., Ltd.—The report shows £113,643 to the credit of revenue. Expenses were £69,343. £6,065 has been deducted as the cost of extending the date of maturity of the debentures; 6s. interim dividend was paid on the first and second preference shares; and 6d. per share (tax free) on the ordinary shares, and after placing £10,000 to general reserve, final dividends of 6s. per share are payable on the preference, and 6d. and a bonus of 3d. per share, both free of tax, on the ordinary shares. The traffic receipts for 1917 increased as compared with those of 1916, but those for 1918 so far show a slight falling off.

Anglo-Portuguese Telephone Co., Ltd.—The gross income for 1917 was £99,506, against £93,578; gross profit, £25,617, against £31,598. After payment of tax, interest, &c., and adding £10,000 to renewals fund, the amount available (including £6,838 brought forward) was £16,092. Further dividend of 3 per cent., less tax, making 6 per cent. for the year; £7,092 forward. The profit was adversely affected by a further fall in the Exchange value of the Portuguese currency. The actual loss on remittances amounted approximately to £22,000, an increase of £6,000.—*Times.*

Shropshire, Worcestershire, and Staffordshire Electric Power Co.—A dividend of 5 per cent. is to be paid on the ordinary shares, £17,000 is to be put to reserve, and £4,580 is to be carried forward. By arrangement with the Government, advances up to £200,000 are to be made to the company to enable it to discharge certain commitments in respect of new plant.

Brisbane Electric Tramways Investment Co., Ltd.—Dividend 4s. per share, free of tax, on the ordinary shares, making 8 per cent. for the year, leaving £36,559 to be carried forward.

Merthyr Electric Traction & Lighting Co., Ltd.—Revenue for 1917 from all sources £28,978, as against £27,179. After meeting expenses and putting £2,000 to renewals, £1,000 to deferred maintenance, paying the preference dividend and 6 per cent. on the ordinary, £668 is to be carried forward. The gross revenue of the electricity supply undertaking increased by £61, and that of the light railways by £1,770.

Kidderminster and District Electric Lighting & Traction Co., Ltd.—In respect of the lighting undertaking, after putting £500 to renewals, £500 to reserve, and paying interest on debentures and preference shares, £45 is to be carried forward. In respect of the tramways, £943 is put to reserve, a dividend of 3½ per cent. is paid, and £190 is carried forward.

Shanghai Electric Construction Co., Ltd.—A dividend of 5 per cent., less tax, is now to be paid on the ordinary shares, making 10 per cent. for the year, and a bonus of 2½ per cent., free of tax. £10,000 is put to reserve for renewals, and £5,000 is written off preliminary expenses.

Metropolitan Carriage, Wagon & Finance Co., Ltd.—Dividends: 5 per cent. for the year on the "A" preference shares, 6 per cent. on the "B" preference shares, 1s. per share for the half-year and a bonus of 1s. per share on the ordinary shares.

Lewes & District Electric Supply Co., Ltd.—Revenue for 1917, £3,649; working expenses, £2,405. After meeting debenture interest, putting £600 to renewals, and £200 to reserve, £688 is to be carried forward.

STOCKS AND SHARES.

Tuesday Evening.

Electrical manufacturing shares are taking up a good deal of attention. Interest has been re-stimulated by the bonus of 2½ per cent. declared, in addition to the 7½ per cent. dividend, by the Electric Construction Co. The price of the shares had been strong in advance, and on the announcement they further rose from 23s. 9d. to 26s., the latter price still including the dividend. The declaration had a strengthening effect upon other similar shares, and the market is good throughout. Edison-Swans hardened to 33s., and the 7 per cent. cumulative participating preference at 21s. 6d. are rather better. Westinghouse preference have rallied ¼ after their drop, there being some inclination to average on the part of holders who gave more for their shares. General Electrics are strong. Cromptons are better at 16s. for the ordinary, while the preference are close on their par value at £1. The Brush issues are wanted, and the prices in the Stock Exchange Official List might be advanced, because there are buyers about of the ordinary stock at 45, which is the top price quoted in that list. Shares of the cable manufacturing list are also what the Stock Exchange calls a good market, the same difficulty being apparent now as we have noticed upon previous occasions, to wit, that there are not enough shares to supply the would-be purchasers. Henley's have risen 15s. to 20¼.

The manufacturing group is amongst the few in which there is any business worth mentioning on hand at the present time. Other markets round the House are quiet. The strength of the war stocks has a good effect upon other gilt-edged issues, including those of the commercial companies. Men of the new military age are receiving their medical examination notices, and until such men become more definitely settled it is not to be supposed that there will be any particular demand for stocks and shares, except those of the gilt-edged type. The uncertainty runs through the provinces as well as London circles, and the comb-out in so many industries has resulted in a disinclination on the part of the investor to undertake fresh commitments until it becomes clearer what are likely to be the effects of the latest call to the Colours.

Railway stocks are mostly firm, this again applying more particularly to the steam issues. Underground Electric bonds, however, keep a good market at 77, and for the shares of the London Electric and of the Underground Co. also, there has been a quiet pressure to buy that made its effect felt upon prices.

Not a change has occurred in the list of home electricity shares. Dealers said that business has come to something like a full stop for the time being. Nobody expects, of course, to do much in these during the summer months, and the rationing order as applied to electricity introduces a new element of uncertainty as to profits, which will probably keep people out of the market until the turn of the shares for public favour comes round again.

"Tax-free" stocks in the telegraph group have again improved. There are rises this week in Eastern Ordinary, Eastern Extensions, Globe Ordinary, and Westerns. Globe Preference followed the rest, and rose to their par value of £10. Great Northerns are 20s. higher. The telephone shares are also wanted. Chiles at 7¾ are 5s. higher. There is nothing doing in Marconis, but prices hold their ground with a good deal of strength.

British Columbia Electrics are again better, and have risen for three weeks in succession. This time, the 5 per cent. preference stock at 60½ claims the largest advance, being 2 points to the good, but the preferred and the 4½ per cent. debenture have both hardened. Anglo-Argentine 4 per cent. debenture advanced to 70; Manila Electric Fives at 79 are also better. Brazil Tractions hold their price, but the tone has improved in sympathy with the steady rises that have taken place during the last few business days in Brazilian Government bonds. Mexicans are steadily gaining favour, although there are no quotable changes to report in the prices of utilities. Rubber shares remain depressed, in consequence of the reductions that are being made in their dividends by many of the leading companies, and the falling-off in production that has followed the self-denying ordinance of those concerns which agreed to curtail their output by 20 per cent. this year. Armament shares are quiet, and fairly firm. There is less going on in the tin market.

SHARE LIST OF ELECTRICAL COMPANIES.

	Dividend 1916.	Dividend 1917.	Price May 21, 1918.	Rise or fall this week.	Yield p.c.
HOME ELECTRICITY COMPANIES.					
Brompton Ordinary	9	10	62	—	£7 8 0
Charing Cross Ordinary	5	4	3½	—	6 3 1
do. do. do. 4½ Pref.	4½	4½	3½	—	6 18 6
Chelsea	3	5	3	—	8 6 8
City of London	8	8	13	—	6 10 8
do. do. 6 per cent. Pref.	6	6	9½	—	6 0 4
County of London	7	7	10½	—	6 13 4
do. 6 per cent. Pref.	6	6	9½	—	6 0 4
Kensington Ordinary	6	7	5½	—	6 10 9
London Electric	Nil	Nil	1½	—	Nil
do. do. 6 per cent. Pref.	4	5	3½	—	7 13 10
Metropolitan	5	4	6½	—	6 3 1
do. 4½ per cent. Pref.	4½	4½	6½	—	6 13 4
St. James' and Pall Mall	8	9	7	—	6 8 4
South London	5	5	3⅞	—	7 3 4
South Metropolitan Pref.	7	7	21/-	—	6 13 4
Westminster Ordinary	7	9	6½	—	7 3 10
TELEGRAPHS AND TELEPHONES.					
	Dividend 1915.	Dividend 1916.			
Anglo-Am. Tel. Pref.	6	6	94	—	6 7 8
do. Def.	23/6	1½	22	— ¼	8 14 10
Chile Telephone	6	6	7⅞	+ ⅛	5 1 3
Cuba Sub. Ord.	6	7	9½	—	*7 7 4
Eastern Extension	6	6	15½	+ ½	*5 0 0
Eastern Tel. Ord.	6	6	154½	+1	*5 3 7
Globe Tel. and T. Ord.	7	7	14⅜	+ ⅜	*4 18 5
do. Pref.	8	8	10	+ ⅜	8 0 0
Great Northern Tel.	22	24	37½	+1	6 8 0
Indo-European	13	13	48⅝	—	6 14 0
Marconi	10	15	3¾	—	4 17 10
Oriental Telephone Ord.	10	10	4½	—	2 7 0
United R. Plate Tel.	6	6	7	—	*5 15 4
West India and Pan.	6d.	6d.	1½	—	*2 6 8
Western Telegraph	7	8	15½	+ ⅜	*5 3 1
HOME RAILS.					
Central London, Ord. Assented	4	4	6½	—	6 8 0
Metropolitan	1	1	20⅜	—	4 18 5
do. District	Nil	Nil	13⅜	— ¼	Nil
Underground Electric Ordinary	Nil	Nil	1½	+ ¼	Nil
do. do. "A"	Nil	Nil	4/6	—	Nil
do. do. Income	6	4	77	—	*5 4 0
FOREIGN TRAMS, &c.					
	Dividend 1915.	Dividend 1916.			
Adelaide Sup. 6 per cent. Pref.	6	6	4½	—	5 6 4
Anglo-Arg. Trams, First Pref.	5½	5½	2½	—	—
do. 2nd Pref.	5½	—	2½	—	—
do. 5 Deb.	5	5	64	—	7 16 4
Brazil Tractions	4	4	43	—	—
Bombay Electric Pref.	6	6	9½	—	6 6 4
British Columbia Elec. Ry. Pfce.	5	5	60½	+2	8 5 4
do. do. Preferred	Nil	Nil	41½	+1	Nil
do. do. Deferred	Nil	Nil	34	—	Nil
do. do. Deb.	4½	4½	64	+1	6 12 10
Mexico Trams 5 per cent. Bonds	Nil	Nil	87½	—	Nil
do. 6 per cent. Bonds	Nil	Nil	80	—	Nil
Mexican Light Common	Nil	Nil	17½	—	Nil
do. Pref.	Nil	Nil	26½	—	Nil
do. 1st Bonds	Nil	Nil	88½	—	—
MANUFACTURING COMPANIES.					
Babcock & Wilcox	15	15	88	—	4 8 8
British Aluminium Ord.	7	10	14⅞	+ ⅛	6 5 0
British Insulated Ord.	17½	20	89	—	5 10 4
British Westinghouse Pref.	7½	7½	22½	+ ½	6 17 0
Callenders	20	20	17	—	5 17 8
do. 5 Pref.	5	5	4	—	6 5 0
Castner-Kellner	22	20	81½	—	5 17 4
Edison Swan, fully paid	—	—	23	+ ½	Nil
do. do. 4 per cent. Deb.	4	4	75a	—	5 6 0
Electric Construction	7½	7½	1⅞	+ ⅛	7 12 4
Gen. Elec. Pref.	6	6	10½	—	5 15 8
do. Ord.	10	10	20½	—	4 18 9
Henley	25	25	20½	+ ½	6 4 0
do. 4½ Pref.	4½	4½	9½	—	5 12 2
India-Rubber	10	10	15½	—	*6 8 0
Telegraph Con.	20	20	43	—	*5 13 0

*Dividends paid free of income-tax.

MARKET QUOTATIONS.

It should be remembered, in making use of the figures appearing in the following list, that in some cases the prices are only general, and they may vary according to quantities and other circumstances.

Wednesday, May 22nd.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Oxalic	per lb.	1/6	..
a Ammoniac Sal	per ton	£80	..
a Ammonia, Muriate (large crystal)	"	£75	..
a Bisulphide of Carbon	"	..	..
a Borax	"	£43	..
a Copper Sulphate	"	£67 10/-	..
a Potash, Chlorate	per lb.	2/6	..
a " Perchlorate	"	2/-	..
a Shellac	per cwt.	£17 10/-	£5 dec.
a Sulphate of Magnesia	per ton	£15	..
a Sulphur, Sublimed Flowers	"	£95	..
a " Lump	"	£25	..
a Soda, Chlorate	per lb.	1/1	..
a " Crystals	per ton	17/-	..
a Sodium Bichromate, casks	per lb.	..	..
METALS, &c.			
c Brass (rolled metal 2" to 12" basis)	per lb.	..	..
c " Tubes (solid drawn)	"	..	..
c " Wire, basis	"	..	..
c Copper Tubes (solid drawn)	"	1/7 to 1/7½	..
g " Bars (best selected)	per ton	£147	..
g " Sheet	"	£147	..
g " Rod	"	£147	..
d " (Electrolytic) Bars	"	£195	..
d " " Sheets	"	£152	..
d " " Wire Rods	"	£193	..
d " " H.C. Wire	per lb.	1/4	..
f Ebonite Rod	"	3/-	1d. dec.
f " Sheet	"	2/6	..
n German Silver Wire	"	2/3	..
h Gutta-percha, fine	"	6/10	..
h India-rubber, Para fine	"	3/3	1d. inc.
i Iron Pig (Cleveland warrants)	per ton	Nom.	..
l " Wire, galv. No. 8, P.O. qual.	"	£42	..
g Lead, English Pig	"	..	..
g Mercury	"	Nom.	..
e Mica (in original cases) small	per lb.	6d. to 3/-	..
e " " " medium	"	3/6 to 6/-	..
e " " " large	"	7/6 to 14/- & up.	..
d Silicium Bronze Wire	per lb.	1/6½	..
r Steel, Magnet, in bars	per ton	..	..
g Tin, Block (English)	"	..	..
n " Wire, Nos. 1 to 16	per lb.	4/6	..

Quotations supplied by—

a G. Boor & Co.
c Thos. Bolton & Sons, Ltd.
d Frederick Smith & Co.
e F. Wiggins & Sons.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakespears.
h Edward Till & Co.
i Bolling & Lowe.
l Richard Johnson & Nephew, Ltd.
n P. Ormiston & Sons.
r W. F. Dennis & Co.

Conservation of Natural Power Resources in Australia.

—An article on hydro-electric power development in Australia and New Zealand, published in *Power*, of April 2nd, touches a question which is now of great interest to many. It appears that the Australians have decided to make as wide a use as possible of their natural power resources in the future, and also that they are not willing that these resources shall be exploited by private capital, but shall be developed by the nation in the interest of the nation.

The realisation of the great importance which hydro-electric development will play in the economic life of Australia and New Zealand so far has found expression in the carrying-out of vast schemes of hydro-electric power generation. Of these, the great development contemplated in the North Island of New Zealand deserves special attention. When completed, this enterprise will not only tap most of the best power sources known at present, but will also be interconnected in such a way as to make the resources of each development available for all the other developments.

The whole of the work is carried out by the Government, which will be the owner of the generating stations and of the means of distribution. The cities and large consumers of electrical power will buy from the Government. By this scheme a guarantee is offered that the resources of the country will be developed so as to give the best results.

Australia and New Zealand have been very far-sighted and fortunate in taking early steps to prevent the unhealthy exploitation of their natural power resources. Laws passed years ago made the undertaking of electrical enterprises dependent upon Government licence, and when the time came to tap the great dormant power resources of the country the Government's position was strengthened by additional laws, giving to the nation virtual control of all the existing resources.

Breaking Power Line Insulators.—A boy named Freeman Field, of Stanley, was charged, last week, with damaging an insulator belonging to the Yorkshire Electric Power Co., Ltd., by throwing stones at it. Owing to the breaking of the insulator, the current was interrupted for two hours, and several collieries and a large munition works were seriously affected. The live wire fell into a field. The boy was ordered to pay 15s. 2d. costs, and was placed on probation for two years.

Exports and Imports of Electrical Goods during January, February, and March, 1918.

The official returns of electrical exports and imports for the months of January, February, and March, 1918, which we publish below, show as regards the exports, totals of £225,585, £255,064, and £174,482 respectively, which compared with the three preceding months — October, £345,365; November, £326,684; and December, £288,956—show a falling-off in value in all sections. The electrical imports for the three months under review were :— January, £212,434; February, £163,788; and March, £200,966; these compared with £224,475 in October, £254,644 in November, and £294,883 in December indicate a downward tendency.

The re-exports of foreign and Colonial electrical material fluctuate considerably in value, the figures being :—January, £11,661; February, £9,036; and March, £3,132; as compared with £14,296 in October, £5,206 in November, and £9,541 in December.

Exports and Imports of Electrical Goods and Machinery, January, February, and March, 1918.

	January.			February.			March.		
	Exports.	Imports.	Re-exports.	Exports.	Imports.	Re-exports.	Exports.	Imports.	Re-exports.
Electrical goods and apparatus unenumerated	£31,418	£27,491	£5,438	£40,327	£24,640	£1,441	£41,045	£30,690	£955
Insulated wire and cable (not telegraphic or telephonic)	13,088	315	86	13,487	287	1,959	15,500	38	119
Electric glow lamps	8,325	33,797	619	7,129	10,282	2,683	7,544	2,907	238
Arc lamps and parts (not carbons)	2,546	12,149	3,700	4,724	1,028	354	4,568	18,717	100
Meters and instruments	9,359	1,139	42	6,552	446	563	6,819	302	—
Electrical machinery (including switchboards and transformers)	97,625	81,487	1,298	104,336	107,912	535	66,778	134,840	1,113
Batteries	6,389	46,439	161	9,274	14,907	308	5,256	10,529	499
Carbons	445	5,697	77	469	2,026	—	578	1,167	45
Telegraph and telephone wire and apparatus...	56,390	3,920	240	68,766	2,260	1,193	29,394	1,776	63
Totals	£225,585	£212,434	£11,661	£255,064	£163,788	£9,036	£174,482	£200,966	£3,132

NOTES ON WELDING SYSTEMS.

The paper read by Capt. J. Caldwell, M.I.E.E., R.E., before the Institution of Engineers and Shipbuilders in Scotland on January 22nd was discussed at later meetings. An abstract of the paper was given in the Electrical Review of January 25th and February 1st.

Mr. T. T. Heaton said that he did not think that any welds should be used, especially where there was any risk to human life, which had not been thoroughly tested. In many cases it was quite easy to test welds, but there were certain things to which no pressure test could be applied. A test which he had used successfully for a number of years consisted of making the weld and hammering it with a hand hammer smartly, with the object of breaking any superficial skin, and then dabbing petroleum on the inside of the weld. Petroleum had a very penetrating power, and if there were a defect in the weld it would show itself in a few seconds. It was not wise to say that any system was the best; it was probably correct to say that each of the systems referred to was the best for some given piece of work. In its place, the system known as the carbon-arc system could not be beaten for efficiency and speed. Considered from the point of view of the metal itself at the weld, no system of welding produced such an excellent result as the resistance method. The resistance method, however, should be looked upon as one suitable chiefly for highly-specialised work, and that was the case more especially in regard to roller welding. He was strongly of opinion that welding would be still more largely used in the future, in the place of riveting or seaming, than it had been in the past. It had been stated frequently that the carbon-arc process hardened the metal at the weld by introducing carbon into it. It could not be too strongly insisted upon that this was not the case, provided that the polarity of the work was properly arranged—that was to say, the work must be the positive pole and the carbon the negative pole. The whole question deserved the careful attention of engineers, because the systems of welding described in the paper were capable of producing joints infinitely superior to those that could be produced either by riveting or any other method. It was not easy to train welders to a state of efficiency without considerable time being occupied in doing so. The most effective method was to train men each for a given job, and to keep them occupied on that job. They then became skilled in the one operation, whereas it was exceedingly rare to find a welder who was capable of undertaking varied work.

Dr. C. H. Desch said he wished to make a few remarks, by way of warning, from the metallurgical point of view. They were apt, he was afraid, to incur certain dangers which were not at first apparent to the engineer, but which at once became apparent when metallographic methods were applied. It was so very easy to join two pieces of metal by these processes which were called "welding," but which were really autogenous soldering, that one did not always realise that the metal was permanently changed in the course of the process. In a well-made smith's weld there was practically no difference to be seen, but in making a weld by any process of autogenous soldering the metal was heated to a very high temperature, besides bringing about a change in its chemical composition. He was speaking rather of structural changes brought about by high temperature. He exhibited photomicrographs of electric-arc welds made by one of the processes mentioned by Capt. Caldwell, with the electrode coated with a fluxing material. The mild steel plate used had a normal structure, and it would be seen that there had been re-crystallisation of the steel, giving an overheated structure. The weld as shown in one of the photographs was practically free from carbon, but contained a little oxide. He had an analysis made of the metal, and found that there was a considerable increase in nitrogen in the weld; the amount was not very large absolutely, but it was ten times as great as in the steel plate. Nitrogen had the effect of rendering steel strong with respect to tensile strength, but brittle, and, as a matter of fact, the welds did prove in this particular case to be brittle. They were not burned; they were made by a thoroughly skilled workman, and were apparently good welds, but the metal was hard, and showed a certain amount of brittleness. Some of his photographs also showed the presence of oxide. He did not wish it to be inferred from that that the welding necessarily injured the metal. A great deal depended on the thickness of the metal and the amount of local heating. He did not think that the defects which he had shown would have any effect at all in lowering the tensile strength of the welds, and the piece as a whole would probably not be affected, even in regard to elongation, but he thought that anything in the nature of a fatigue or shock test would show considerable weakening.

Prof. Malcolm M. Irvine said there was a notable difference between the acid flux and the basic flux when used in electric welding. The acid flux when in a fused condition had a higher surface tension, and tended to mix with the molten metal. This property was of great significance in connection with vertical welding and overhead welding, such as was frequently met with by boilermakers. The users of acid fluxes adopted what might be called the "broken arc" system. In using this system a rather heavy current was employed, so that during the time the arc was struck the part to be welded, and the welding material, would be completely fused. The flux at that moment—that was, during the period the arc was struck—became molten, and formed a pellicle of slag round the molten tip of the electrode, which was immediately projected on the part to be welded. The welder then hammered this metal immediately it was applied, so as to render it quite homogeneous. The process of striking up the arc, projecting the metal, and hammering was repeated and carried on continuously until the weld was complete. That system was quite different from the "continuous arc" system of welding, such as was embodied in the quasi-arc, the double-arc, and other processes of welding in which neutral or basic slags were employed. In these processes the slags used were mostly basic, and were made so that they would fuse at a certain temperature, considerably below the melting point of iron. The flux must not have too low a melting point, otherwise it left the electrode bare; neither should it have too high a melting point, otherwise the metal would run down and leave a tube of slag which would break the arc. The slag also possessed the property of diffusing over the surface of the molten metal. This was necessary to prevent oxidation. If an abundance of slag were used on a horizontal weld, so that the arc would be completely protected by the slag, then the possibility of oxidation and the combination of nitrogen was greatly prevented. Electric welds, when compared with oxy-acetylene welds, were invariably found superior with respect to tensile strength. Acetylene welds, on the other hand, generally had a higher elongation. The elongation of electric welds was greatly increased by annealing, but this was not always possible, and in circumstances where elongation was particularly desired the welding must be done in a most careful manner. It must be done with the minimum amount of current, and with the shortest and steadiest arc the operator was capable of working with. This naturally pointed to the employment of skilled operators. The operators almost invariably used an excessive amount of current, with the result that the weld was more

crystalline, contained a higher percentage of nitrogen, and caused a greater disturbance in the adjacent metal than would be the case if the weld were made under the correct conditions. The work of training welders was rather expensive, and he threw out the suggestion that electric welding should be taught at the Royal Technical College in conjunction with oxy-acetylene welding. At the present time, unfortunately, certain types of welding plant were on the market which were stated to be suitable for either carbon-arc welding or, alternatively, for welding with metal electrodes. It was not possible to do good welding with plant suited for the carbon arc when using metal electrodes. The resistance for carbon-arc welding gave too great a voltage for the arc, with the result that metal electrodes when used on such a resistance deposited the metal in a very granular condition, and frequently in a burned condition. Welds made in that way with a metal electrode gave a tensile strength of 10 or 11 tons, whereas the same metal electrodes used under the proper conditions, and with the proper current, gave a tensile strength of about 32 tons. The remedy, of course, was obvious. Capt. Caldwell, in the course of his paper, opened up an interesting vista of electric welding in its application to shipbuilding. He was not in a position to give a comparison of the costs of electric welding with riveting processes, but he could give the assurance that electric welding in practically every form of shipyard welding was cheaper than welding with the oxy-acetylene process. It was also very much quicker, being in many cases more than twice as quick as the oxy-acetylene process. It was only in the thinner sheet-metal that oxy-acetylene welding compared favourably with electric welding, and, in fact, at the present time for a thickness of 1/16 in., oxy-acetylene welding was really cheaper than electric welding, but above that electric welding was cheaper. He was certain that the cause of that was the price of the electrodes. If the demand for electrodes became considerable, then the price of them would fall very greatly, and under such circumstances electric welding would be incomparably the cheapest and best form of welding for shipyard work.

Dr. J. H. Paterson remarked that his firm had used all types of electric welding processes; they had used electric-welding processes without any flux at all, and he might say that with reasonable care, so far as the quality of the metal was concerned, they found that they could get very nearly as good a metal with the bare electrode as they could get with any kind of flux. He did not say that it was as good a weld, but so far as the metal applied was concerned, he had not been able to prove to his own satisfaction that any one of the fluxes he had come across had been of outstanding merit when compared with the bare metal electrode. The Admiralty and some private firms had conducted many tests, and these tests went to prove that with direct tension a good welded lap-joint was undoubtedly stronger than a riveted joint, but when one came to applying alternating- or bending-stress tests there were no results which proved anything at all. If the construction of the test pieces were analysed it would be found that the stresses were not applied to the metal in the weld at all. This was on account of the fact that the metal in the weld and the metal joined together usually had very different mechanical properties, and the applied test merely demonstrated the approximate efficiency of the least efficient material. He was of opinion that it was time that someone who had no real connection with the financial side of the business should take the matter in hand, and should publish for the benefit of everybody interested at least the outlines of his research, which would place the whole subject on a sound basis. Finally, he might say that electric welding offered almost dazzling prospects, particularly to the shipbuilder. In a report written from one of the Admiralty dockyards, where electric welding processes had been extensively applied, it was claimed that electric welding, if applied instead of riveting, would reduce the cost of labour on the ship by 75 per cent. His want of confidence in welding was due to want of knowledge from a metallurgical point of view—and, moreover, want of knowledge of the type of test to apply in order to get accurate and reliable results. Once they had solved the problem of a weld which would contain no oxygen, they would be in a much better position to estimate the value of electric welding.

Mr. E. H. Jones observed that what he had been endeavouring to do was to find some means of welding steel alloys, so that the metal in the weld should be at least as strong as the metal welded, but he, in common with many other experimenters, had found that it was impossible to weld alloys with an alloy metal so as to make a satisfactory job, as the use of such metals gave rise to porosity, and as the proportions of the rare metals to form the alloy increased, the porosity increased proportionately. Tests which were made with an 80-ton tensile strength alloy formed into welding electrodes showed a strength in the weld made of only *six* tons, due to the cause referred to. He had found that if metals to form an alloy were kept apart until the moment the weld was made, it was comparatively easy to effectively weld any steel alloy. The nickel-coated electrodes referred to by the author of the paper were prepared for the welding of different grades of nickel steel up to 50 tons tensile strength, and particularly for the repair of motor-car crankshafts, driving shafts, axles, and gears, &c., they were proving very successful. He had found that it was of particular importance that the metal added to effect a weld should be superior to that of the work. No matter how the weld was effected there was bound to be a certain deterioration in the metal of the weld, and not only in the weld, but in the metal adjacent to the weld, and if the weld metal was superior to that of the work it would restore and make good the deterioration by diffusion. Experiments he had made with electrodes of high-speed steel showed that the deposition of, or welding with, high-speed steel was impossible, so far as his present knowledge went, but he had found it to be fairly easy to accomplish if the metals to form the alloy were kept apart until the moment of fusion, either with the oxy-acetylene blow-pipe or with the electric arc. He sent to the Institution for inspection by the members some sections of high-speed steel electrodes, or, rather, electrodes to form high-speed steel. They were composed of a channel of mild steel within which the various rare metals to form the alloy were placed, these being powdered and worked into a paste which was run into the channel. To give the carbon content he had found the best way was to add a rod of cast iron, and the carbon in this, diluted by the mild steel and other iron present with the ferro-alloys gave the required proportion. These electrodes were fused on to the work, which, for example, might be a tool shank, by a current of about 200 amperes, and it was easy by this method to obtain a perfectly homogeneous deposit possessing any desired proportion of the rare metals. These electrodes would very shortly be marketed. He would like to take this opportunity of drawing attention to the undoubted merits of alternating current for arc welding. For some reason which he was unable to fathom, the general impression was that continuous current was superior to alternating for arc welding, but, as a matter of fact, he found that alternating current was far superior to continuous, and he would recommend the use of alternating current on every possible occasion. Apart entirely from the capital outlay needed, which was vastly higher in the case of continuous current, the control of the current was much easier to effect. He estimated that the amount of current which would be necessary to feed 20 operators with continuous current would suffice to feed 28 with alternating current.

Mr. O. A. Payne, R.C.N.C., stated that experimental work had been carried out at Portsmouth, and proved beyond doubt that when dealing with plates up to about 20 lb.—(*a*) A widely-spaced single row of rivets connecting two plates with a single run of weld along one edge was stronger than the usual single row of rivets with water-tight spacing. (*b*) A widely-spaced single row of rivets with a single run of weld on one side and an intermittent run of weld on the other was stronger than a double row of rivets with water-tight spacing. (*c*) Where a plate butted on another, *e.g.*, a transverse frame on a continuous longitudinal, a much stronger connection could be made by welding than by the usual angle lugs. (*d*) A thin plate welded between the rows of rivets of a shell buttstrap was effective in enabling complete water-tightness or oil-tightness to be obtained when dealing with leaky butts. (*e*) A plain butt "veed" and welded was quite as strong as, or stronger than, the best riveted joint obtainable, whether riveted by hand, hydraulic, or pneumatic machine in double or treble rows. These and a great number of other experiments had been carried out, including welding vertically, horizontally, and flat—all of which were designed to be carried out to represent the conditions in which such welding would have to be done in actual practice, with the result that they had full confidence in accepting electric welding as a shipyard method of great potentialities; in fact, experience had shown that the development of electric welding was limited only by the difficulty of obtaining an adequate number of trained welders. It was felt that the process only required the trade of electric welders to be organised and properly established when an immense field for this class of work would develop, and shipbuilders would probably be in much the same position as they were now in regard to pneumatic riveting and caulking—that of wondering how they formerly built ships without it.

A FIFTY-THOUSAND SQ. FT. CONDENSER.*

Some of the notable condensers that have been developed and put in service during the last year or two are, for instance, the 50,000 sq. ft. surface condenser of the New York Edison Co., and also one of the Chicago Commonwealth Edison Co., that serves 30,000-kw. generators. Another large condenser, a Leblanc, serves a 45,000-kw. turbine of the Narragansett Electric Light Co., Providence, R.I. It is designed to handle 18,000,000 lb. of circulating water, condensing approximately 500,000 lb. of steam per hour, an equivalent of 36 lb. of circulating water per pound of steam. The largest condenser so far built is one for the Detroit Edison Co., which has 70,000 sq. ft. of cooling surface.

An installation of large surface condensers, of which there will be six, the largest yet built of the Leblanc surface type, is to be located at the bottom of a pit 74 ft. deep. At present there are two 50,000 sq. ft. surface condensers that serve the two 30,000-kw. turbines installed in the present structure of the Windsor power plant of the American Gas & Electric

* *Power*. Vol. 47, No. 9. Abstract.

Co. Both condensers are of the straight downflow type. Each condenser contains Muntz-metal tubes, of 18 B.W.G., and 18 ft. long. The condensers are 18 ft. inside diameter and 25 ft. long. A portion of the tubes in the upper portion of the condenser, aggregating about 2,400 sq. ft., are used as a primary feed-water heater, through which the condensate is pumped before going to the two open feed-water heaters. The primary heater brings the temperature of the condensate up very near to that of the incoming steam. Each condenser is set below the turbine which it serves. As the turbine must be above the highest point which the river reaches, and the condenser must be low enough to avoid lifting the water at low stages, the 13-ft. diameter exhaust pipe is 40 ft. in length.

Expansion of the pipe and the vertical expansion of the condenser are taken care of by a mercury expansion joint, fig. 1, designed especially for and constituting one of the really novel features of the installation. It is 13 ft. in diameter, and consists mainly of a fairly close-fitting cast-iron sleeve, so formed as to permit a manometric column of mercury to make a seal to prevent air leakage, and at the same time permit of a free motion of the upper and the lower halves of the joints relative to each other. The upper part of the joint is built so that if for any reason the mercury arrangement part of it should fail, an ordinary slip joint with soft packing could be used.

The dotted portion marked "Expansion Joint Clamping Block" is not used with the joint in service. This is simply an arrangement whereby the two portions of the joint can be firmly fastened together for shipment.

It was decided that this type of joint was necessary because the great vertical distance between the condensers and the turbines entailed an extraordinarily great expansion in case the apparatus should be much changed in temperature. The mercury expansion joint can take up an indefinite amount of expansion, whereas there would be a danger that a copper joint, with the great distortions necessary, would ultimately fail.

With each condenser is furnished a horizontal motor-driven circulating pump, having a capacity of 50,000 gallons per minute. There are also two motor-driven Leblanc rotary hydraulic-type air pumps and two motor-driven hotwell pumps. The centrifugal hotwell pumps are driven by 550-volt, 3-phase, 60-cycle squirrel-cage induction motors that are provided with special insulation to withstand the damp atmosphere of the pit.

At this writing no plant tests have been made on the turbines, but assuming 12 lb. of steam per KW.-hour, each condenser will take care of 360,000 lb. of steam at rating or 7.2 lb. per sq. ft. of cooling surface, and 8.3 gal. of circulating water per pound of steam condensed at rating. Per KW. of generator rating the condenser contains 1.67 sq. ft. of cooling surface.

The opening into the condenser pit is centrally between the steam ends of the two turbines, the foundations of which are formed by the walls of the condenser pit. The Ohio River at Windsor has a rise of 50 ft. from extreme-low to extreme-high water, which necessitated the construction of a condenser pit with the bottom 74 ft. below the turbine-room floor. The basement floor is just about the high-water mark, and the main floor is 18 ft. higher. With the condenser-pit floor 74 ft. below the turbines, it was possible to place the centre line of the circulating pumps at the same elevation with the extreme low level of the river, thus reducing the cost of pumping the circulating water to a minimum.

Steel cross members support the condenser at a height of about 15 ft. above the floor of the condenser pit, which provides space for the circulating, air, and hotwell pumps. The concrete intake and discharge tunnels for the condensing water are built to take care of the proposed ultimate capacity of 200,000 KW. Water coming from the Ohio River through the intake tunnel goes to an intake crib inside the turbine room; the water passes successively through bar-iron grills, travelling screens, and stationary screens to the rear chamber of the crib. The 84-in. diameter cast-iron suction pipe of the circulating pumps drops to this chamber. Water from the condensers discharges from a side outlet on the upper side at one end through a 54-in. cast-iron pipe into a discharge well.

Each circulating pump intake pipe is provided with an extra-heavy sluice gate, operated by a hydraulic cylinder for controlling the flow of water to the pumps. The travelling screens are mounted in a vertical position, and are so arranged that they can be raised or lowered.

The intake and the discharge tunnels from the river to the intake in the station building required approximately 30,000 cu. yd. of excavation, 5,300 cu. yd. of concrete, and 270 tons of reinforcing. The condensing pit, which is 25 ft. 6 in. wide, 91 ft. long inside, and 74 ft. deep, required approximately 32,000 cu. yd. of excavation, 13,500 cu. yd. of concrete placed, and 514 tons of reinforcing steel, as well as 315 tons of structural steel used in the construction.

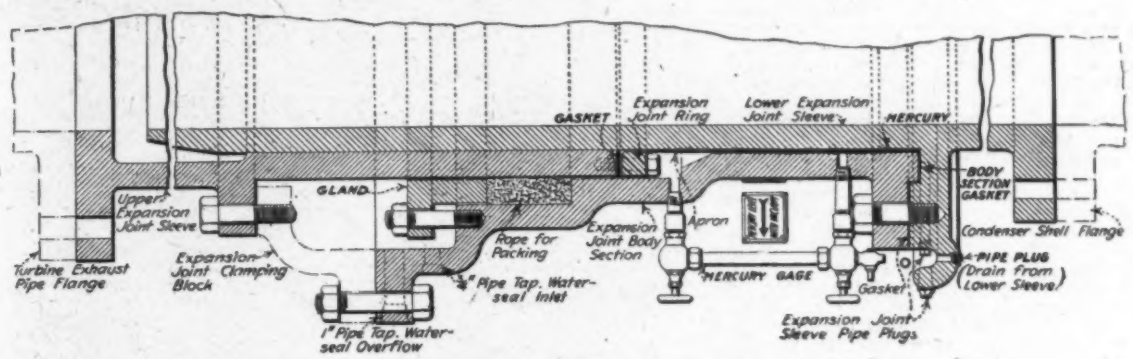

FIG. 1.—SECTION OF MERCURY EXPANSION JOINT.

ELECTRIC SIGNALLING AND CONTROL ON RAILWAYS.

THE paper by Mr. C. M. JACOBS, which was abstracted in the ELECTRICAL REVIEW of January 18th, was read and discussed before the MANCHESTER LOCAL SECTION of the INSTITUTION OF ELECTRICAL ENGINEERS on January 15th, 1918.

Mr. J. SAYERS said that each signal box, on the main line at least, was really a little power centre or station, which required a supply of electrical energy on quite a large scale as regarded the number of circuits. On the Midland Railway alone, in connection with signal-box circuits, there were roughly 150,000 primary batteries. Automatic signals of the arm type required quite a considerable expenditure of force to make certain that they would operate in all weathers; a battery had to be provided which would supply a very considerable ampere output with a low internal resistance. The number of primary batteries which would operate such signals was very limited indeed. Unless they could put in a continuous power main, the problem of supplying automatic signals was very difficult. He found that a unit of energy from an ordinary Leclanché cell cost about 50s. in pre-war times; it was probably now cheap at £3. On the point of economy alone it was desirable that they should be able to get electric power for doing these things from a central station. In his opinion the development of proper control of signalling was in the direction of making it more automatic, and this development was going to be stopped unless they could get a proper supply of energy along the railway which was not too costly, and which must be absolutely reliable. On the railway between New York and Chicago they had a system of controlling automatic signals, without any trouble, by having a continuous overhead power line along the whole line, and they fed into that any sort of supply they could get. By this method they ensured that if there was a failure of supply at one place they could get a supply from the other direction. The author said that a non-contact method of train control would have been preferred, but so far no such scheme had been considered practicable; but there were some who thought that an inductive method was likely to be practicable. Only those who worked on the railway knew the trouble there was with obstruction, and in no place was obstruction worse than between the running rails. The Great Western system was one of the ramp methods, and, in his opinion, was the best of them all. It had been in use on one of their lines for something like 10 years, and it did exactly what it was put in to do. With an inductive method, it was essential to have a conductor along the whole length of the line, supplied with alternating current at a predetermined frequency. The tuned reed relay of Kramer and Kapp would operate continuously and make a contact with a frequency of 100, breaking at above 105 or below 95. With a system of this kind with such a relay, they

had continuous control of the train from the time it started to the time it stopped. One of the limitations of such a system at present was the necessity for power, which had to work 24 hours a day, seven days a week. It seemed that both the old forms of control and those which would probably be used in the future on the railways depended upon a proper supply of power. The opposition of railway companies to the transmission of power near their lines resulted from the difficulty of preventing induction on the telephone circuits. As regarded a power line paralleling a railway, if one could get a company to put up a three-phase line and guarantee that the phases would be equally balanced, and that, if necessary, they would cross the power lines and transpose them, he did not think it would be found that any railway company would put difficulties in the way. With, however, a single-phase line, or a three-phase line which had its phases unbalanced, that would almost certainly cause trouble with the telephone lines.

Mr. P. Lomas referred to the pessimistic view the author seemed to take of his profession. He had in mind something like 300 sections of track circuit, and the failures on the relays connected with these worked out at considerably less than one failure in a million operations. That was hardly just cause for pessimism. It was only fair to electric signal engineers that it should be realised that although failures did occur they were not nearly so frequent as they would be with mechanically-operated devices. The author said a track circuit could not be depended upon to detect anything which did not put virtually a dead short-circuit across the rails. In practice the term "short circuit" was a comparative one. On the London and North-Western Railway no track circuit was allowed to remain in use if it would not operate with 1 ohm joined across the rails, and having once operated it would not restore itself until the value of the short-circuit caused by the train wheels rose to about 5 or 6 ohms. When dealing with railway track-circuits, with timber sleepers and wet cinders for insulation, instead of reckoning insulation resistance in megohms they often had to reckon 2, 3, or 4 ohms as a fair insulation resistance.

Mr. J. D. Paton said that no attempt should be made to establish a system by which the signals were not a part of the locomotive. In the Simmen-Northey system the signals on the ground were cut out. The signals were given in the engine cab. In this country they worked on the principle of making sure about the "danger" and then going ahead; in the States they worked on the "all clear." The man in the Simmen control house had a panel in front of him which represented the entire system of blocks of which he was in control. Every train on that system was moving on that panel, and he actually saw a small needle perforating the position of the trains inside the blocks. In a Court of Law these records were now recognised as superior evidence to oral evidence in a case of accident. This system had reached a point where it had become a great success.

Mr. W. A. Barnes said that alternating-current traction had yet to prove its case in this country; heavy electric traction was almost wholly direct current, and the probabilities were that extensions would be on the same lines, especially where suburban traffic had to be dealt with. The system adopted for electrical signalling should be adapted to the kind of electric traction in use rather than as suggested by the author. On the Manchester-Bury electrified section of the Lancashire and Yorkshire Railway, track signalling with batteries was in use prior to the electrification, but, owing to the voltage drop in the track rails being very variable, and under certain and frequent conditions higher than the voltages used for the track circuits, it was necessary to change over to alternating current for the track circuits. There was an A.C. lighting line running the whole length of the electrified sections, used primarily for the lighting of stations, and power was taken from this through transformers for track circuits. The operation had been quite satisfactory. It would seem essential that electrical signalling should be operated primarily by alternating current.

Mr. A. Davies said that on the Midland Railway the rotary block instrument was an arrangement which combined the block telegraph circuit with the outside signalling installation, and ensured that a signal should not be lowered to permit a train to travel along the line other than that for which the necessary permission had been given.

Ald. W. Walker was under the impression that, from the first, all schemes for the long-distance transmission of electrical energy had been opposed by the railway companies; they had not wanted transmission lines anywhere near their railways. In the discussion the electrical engineers of railways had complained because current was not available at every point on their systems where they now required it for some particular purpose. He rejoiced therefore that at last their assistance might be expected in the development of high-tension transmission, overhead or otherwise.

Mr. C. M. Jacobs, in reply, said with regard to automatic train control, he agreed that it was desirable to keep the railway free from all unnecessary obstruction. He did not think, however, that those who believed in an inductive method of signalling to the train had yet shown them a practical scheme worked out in all its details. From a purely signalling point of view he did not think a continuous indication of the train was necessary. The present semaphore system of signalling gave intermittent indications, and these, if they were properly observed, were found to be sufficient.

NEW PATENTS APPLIED FOR, 1918.

(NOT YET PUBLISHED.)

Compiled expressly for this journal by Messrs. Sefton-Jones, O'Dell and Stephens (successors to W. P. Thompson & Co., of London), Chartered Patent Agents, 285, High Holborn, London, W.C. 1.

7,550. "Apparatus for correcting electric impulses." Automatic Electric Co. (Automatic Telephone Manufacturing Co., U.S.A.) & F. C. Tomlins. May 6th.

7,581. "Overload time-limit relays for electric circuits." British Westinghouse Electric & Manufacturing Co. May 6th. (U.S.A., May 7th, 1917.)

7,584. "Electric signal systems." C. E. Lyman. May 6th.

7,596. "High-frequency generators." Marconi's Wireless Telegraph Co. and I. Schoenberg. May 6th.

7,610. "Sparking plugs for internal-combustion engines." H. V. J. Jouffret. May 7th. (France, October 24th, 1917.)

7,616. "Telephone." A. James & A. T. Thompson. May 7th.

7,619. "Electric apparatus for controlling curtains and lights in connection with projecting screen for proscenium of theatres, &c." C. E. Falconbridge & J. W. Leyley. May 7th.

7,629. "Flexible conductors." Western Electric Co. (Western Electric Co., U.S.A.) May 7th.

7,643. "Apparatus for detecting variations in magnetic fields." D. K. Morris. May 7th.

7,649. "Switch for high-voltage circuits." E. G. C. Barton. May 7th.

7,659. "Electric relays." S. G. Brown. May 7th.

7,685/7. "Electrolytic production of zinc." C. H. Clevenger. May 7th. (U.S.A., May 7th, 1917.)

7,668. "Control of magneto-electric generators for effecting ignition in internal-combustion engines." C. H. Grace. May 7th.

7,680. "Maintenance of electric oscillations." T. A. Garrett. May 8th.

7,693. "Electric heating quilts, blankets, &c." H. A. Duxbury & R. O. de K. Hall. May 8th.

7,701. "Electric switches and starters." R. H. Barbour. May 8th.

7,702. "Sparking plugs for internal-combustion engines." H. V. J. Jouffret. May 8th. (France, January 14th.)

7,705. "Manufacture of the metal magnesium and/or alloys of magnesium with other metals by electrolysis." E. A. Ashcroft. May 8th.

7,711. "Telephone systems." Western Electric Co. (Western Electric Co., U.S.A.) May 8th.

7,718. "High-frequency machine with turbine drive." Allgemeine Elektricitats Ges. May 8th. (Germany, January 24th, 1917.)

7,722. "Protective devices for electric circuits." British Thomson-Houston Co. (General Electric Co., U.S.A.) May 8th.

7,724. "Machines for slotting commutators, &c." S. E. Aurand. May 8th. (U.S.A., May 11th, 1917.)

7,735. "Starting devices for internal-combustion engines." O. Imray (Bosch Akt. Ges.). May 8th.

7,745. "Prizing devices for electrical machines." Aktiebolaget Ljungstroms Angturbin & Brush Electrical Engineering Co. May 8th.

7,770. "Combined plug, socket and switch fitting for electric circuits." V. Hope. May 9th.

7,775/6. "Means for igniting charge in internal-combustion engines." G. M. Blackstone, E. Carter & F. Carter. May 9th.

7,824. "Electric heating of rivets, studs, bolts, &c." W. Meacher. May 10th.

7,849. "Tubular earths for electric conductors." K. W. Hodges. May 10th.

7,866. "Minimum current cut-out and apparatus for regulating tension and voltage and current from a dynamo." Fabbrica Italiana Automobili Torino & R. B. Ransford. May 10th.

7,877. "Ignition magnetos for internal-combustion engines." J. H. Chambers & H. Lucas. May 10th.

7,881. "Transformer." H. E. Steinbock. May 10th.

7,888. "Electromagnetic devices for use in signalling circuits." J. J. Grehgan. May 10th.

7,905. "Trolley heads for electric traction." J. B. Parker & J. Smith. May 10th.

7,920. "Wireless telephony." L. F. Blandy & R. Whiddington. May 11th.

7,957. "Control of power absorbed in electric furnaces." D. F. Campbell. May 11th.

7,961. "Electromagnetic separator." T. I. Coppin. May 11th.

PUBLISHED SPECIFICATIONS.

The numbers in parenthesis are those under which the specifications will be printed and abridged, and all subsequent proceedings will be taken.

1916.

5,442. Electric Induction Furnaces. C. B. Foley. April 13th, 1916. (114,853.)

13,303. Transmitting Apparatus of Radio-telegraph Stations. F. G. Simpson. September 19th, 1916. (114,854.)

17,988. Dynamo or Magneto Ignition Apparatus. J. G. Zimmerman. May 12th, 1916. (106,406.)

1917.

3,937. Power Traverses in Electrically-driven Lathes, Boring Mills, and other Machine Tools. G. Stirk, E. Stirk, R. Stirk & J. G. Stirk. March 19th, 1917. (114,868.)

4,808. Manufacture of Electric Cables. C. J. Beaver & E. A. Claremont. April 3rd, 1917. (114,872.)

5,224. Telephone Meters. G. I. Bruschke. April 13th, 1917. (114,876.)

5,410. Electric Heating of Metallic Bodies for Forging or other purposes. D. J. Campbell. April 17th, 1917. (114,885.)

5,503. X-ray Apparatus for Surgical and Medical Use. E. E. Greville. April 19th, 1917. (114,893.) (Cognate applications, 8,759/17, 10,652/17, and 12,814/17.)

5,878. Fuses or Cut-outs for Electric Circuits. V. Hope. April 26th, 1917. (114,906.)

6,053. Working of Signals by Electric Currents. W. J. John & J. John. April 30th, 1917. (114,910.)

8,738. X-ray Apparatus. F. J. Harlow. June 18th, 1917. (114,941.)

10,773. Method of Removing and Replacing Electric Storage Battery Connectors. H. S. Bowler & F. Fremmier. July 20th, 1917. (114,948.)

13,028. Electrodes for Ionic Tubes for use more particularly in Wireless Telegraphy. Osram-Robertson Lamp Works & O. Durdle. September 11th, 1917. (114,968.)

13,883. Electrolytic Cells particularly adapted for the Electrolysis of Salt or similar material. N. Statham. September 20th, 1917. (114,974.)